An Evaluation of
The Science Council of British Columbia
Research Granting Programs*
1979-91

*Assistance Grants for Applied Research, 1979-89

*Science and Technology Development Fund, 1988

*Science and Technology Development Fund — Assistance Grants for Applied Research, 1989-91

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MINISTRY OF ADVANCED EDUCATION, TRAINING AND TECHNOLOGY

EVALUATION OF STDF/AGAR

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EXECUTIVE SUMMARY

PURPOSE OF STUDY

Since 1979, the Science Council of British Columbia has administered a number of programs designed to promote economic development by providing financial assistance for applied research and development. The purpose of this evaluation is to determine the effectiveness of these programs and develop recommendations to improve the current program design.

CONCLUSIONS

The major conclusions arising from our evaluation are as follows:

1. **The Science Council assistance programs for applied research and development have proven very effective in stimulating economic development.**

   The major economic impacts generated by the programs include:

   - **Increased investment in applied research and development.** The costs of the applied research and development projects which received funding from the Science Council totalled $140 million, of which $45 million (32%) was contributed by the Science Council and $95 million was contributed by the proponents, private sector organizations, other government programs and other sources. Of this $95 million contributed from other sources, 45% (about $42 million) would not have been invested in these projects in the absence of Science Council funding. In addition, the results of these initial projects stimulated further investment in applied research and development of $26 million.

   - **Commercialization of many new products and processes.** The applied research projects which received funding from the Science Council have been associated with the commercialization of at least 99 products and processes to date. In addition, our survey identified a further 33 products and processes which are now in their final stages of development and will likely be commercialized in the next 2 to 3 years.

- **Generation of significant revenues and cost savings.** Commercialization of these products and processes has generated cumulative revenues and cost savings of $83 million, which represents a return of $1.70 per dollar of funding provided by the Science Council (expressed in 1991 dollars). A further $116 million in revenues and cost savings (in 1991 dollars) is projected to be generated by these products and processes between 1992 and the year 2000;

- **Employment creation.** Commercialization of these products and processes has led to the creation or maintenance of 830 person-years of employment to date (representing 1.71 person years of employment per $100,000 of funding provided);

The Science Council programs have also enhanced research capabilities, fostered greater cooperation between organizations with respect to applied research, and increased the willingness of B.C. businesses to invest in applied research and development. In addition, Science Council funded projects have benefited the general public through environmental, health and safety improvements.

2. **The need for financial assistance programs which support applied research and development is projected to remain strong.**

Because of the high level of risk associated with applied research and development, it is very difficult for organizations to obtain funding for research from traditional debt and equity financing sources. Programs, such as those administered by the Science Council, play a very important role in filling this financing gap thereby enabling B.C. companies to develop and commercialize new products and processes. It is widely recognized that a strong commitment to research and development is required if B.C. is to continue to compete successfully in an increasingly competitive global-based economy.

3. **The Science Council has proven to be a very effective and efficient mechanism for the delivery of programs providing financial assistance for applied research and**

development.

Through the use of Peer Review Committees, the Science Council has facilitated input from a wide variety of representatives from government, industry and academia into the selection of projects. The volunteer nature of the Peer Review Committees has also served to minimize program administration costs, which have averaged approximately 5% of the value of grants awarded. Administration costs for grant programs usually range between 10% to 15% of the value of the grants awarded.

RECOMMENDATIONS

Given the effectiveness of the Science Council programs to date in generating economic development, it is strongly recommended that the Government of British Columbia continue to provide significant financial support for programs such as Technology B.C. which provide financial assistance for applied research and development.

In order to generate the greatest return per dollar contributed, highest priority should continue to be given to industry-based projects in the allocation of funding. To date, projects sponsored by industry (private sector) proponents have tended to generate greater economic impacts than have research projects sponsored by proponents associated with universities and colleges.

The Science Council should take steps to increase the number of applications received from private sector organizations. Specifically, it is recommended that the Science Council should: focus promotional efforts more directly on private sector organizations; make greater use of seminars, workshops and other face-to-face mediums to promote Technology B.C.; provide greater assistance to the private sector in the preparation of proposals; and revise the application form to make it more appropriate for small and medium sized businesses.

Lastly, the Science Council should strive to establish a greater presence outside of the Lower Mainland and Victoria areas. As of the end of 1990, over 85% of program funding had been awarded to organizations in the Lower Mainland and 99% had been awarded to organizations in the Lower Mainland or on Vancouver Island. In addition to targeting potential applicants from the interior through advertising, seminars and workshops, the Science Council should establish greater stronger links with potential referral agencies as well as with the regionalization initiative established within the Ministry of Advanced Education, Training and Technology.

DETAILED SUMMARY

AGAR AND STDF PROGRAMS

The Science Council of British Columbia was formed in 1978 to advise the Government of B.C. on scientific matters. Shortly after being established, the Science Council identified a need for a program which would provide funding to encourage scientific and technological research in British Columbia in a manner that would create greater linkages between research organizations (particularly universities) and businesses who could apply the findings of the research. With core funding from the Government of British Columbia, the Science Council established the Assistance Grants for Applied Research (AGAR) Program in 1979. Grants were made from the AGAR program to researchers in universities, colleges and institutes and private companies until 1989. Over this period of ten years, 20 competitions were held and $36.8 million dollars in grants were awarded under AGAR.

In 1988, the Science and Technology Development Fund (STDF) was established by the Ministry of Advanced Education and Job Training and the Ministry for Science and Technology. The STDF was used to fund a variety of programs including the STDF Competition which provided grant funding for major single-year applied research projects, as a complement to the longer-term assistance available under AGAR. A budget of $10 million was established for the STDF Competition, of which $2 million was transferred to the Science Council for disbursement through AGAR. The remaining funds were used to support a research grant competition which was held in October, 1988.

In 1989, the AGAR Program and the STDF Program were amalgamated as STDF-AGAR. In 1991, the name of the program was changed from STDF-AGAR to Technology B.C.

PURPOSE OF STUDY

The purpose of the evaluation is to determine the effectiveness of the financial assistance programs in terms of promoting research and development and economic development, and develop recommendations to improve the current program design. The focus of the evaluation, in terms of assessing economic impacts, is on projects funded under the STDF and AGAR programs; it was felt that not enough time had elapsed for projects funded under STDF-AGAR or Technology B.C.

Table I

OVERVIEW OF THE SURVEY PROGRAM IN TERMS OF THE NUMBER OF INTERVIEWS AND QUESTIONNAIRES COMPLETED

Type of Respondent	Number
Program Representatives From Science Council	5
Peer Review Committee Members	87
Proponents of Completed Projects	
• General Questionnaire	219
• Project Specific Questionnaire	300
Proponents of Projects Leading to Commercialization	100
Mini-case Studies	30
Proponents of Withdrawn or Rejected Applications	50
Non-applicants	19
Representatives of Other Programs	10
	820

to have generated economic benefits.

METHOD OF STUDY

Evaluation of the AGAR and STDF programs was conducted in two phases. The purpose of the first phase was to develop an evaluation framework to guide implementation of the evaluation. Based upon this evaluation framework, a detailed evaluation of the AGAR and STDF programs was undertaken in the second phase of the study. This document represents the output of the second phase of the project.

As indicated in Table I, on the opposite page, 820 people were surveyed through personal and telephone interviews and mail questionnaires during the course of the second phase of the evaluation. A description of the methodology is provided in the following paragraphs.

- In order to gain a thorough appreciation of the policy framework, scope and nature of STDF-AGAR, we reviewed the relevant program and policy documentation, and met with representatives of the Ministry of Advanced Education, Training and Technology and the Science Council of B.C. involved in the design, operation, and review of the programs.

- In order to develop a profile of projects and proponents which received funding under AGAR and STDF, we undertook a detailed review of the files on approved projects and rejected applications maintained at the offices of the Science Council.

- In order to obtain feedback on the perceived impacts and effects of the programs, the demand for funding, and the funding guidelines and application review process, we surveyed 5 representatives of the Science Council and 87 representatives of the Peer Review Committees established to make recommendations on project applications. The membership of these committees consists of volunteers. We also surveyed representatives of other programs which provide financial assistance for applied research and development.

- A general questionnaire and a project specific questionnaire were distributed to 401 proponents covering the 527 projects which were funded under STDF or AGAR.

We received responses from 219 proponents covering 300 projects, equal to a response rate of 57%. The purpose of the general questionnaire was to obtain feedback from the proponents regarding source of awareness of the programs, level of satisfaction, and future demand for funding. The purpose of the project specific questionnaire was to identify the outcomes and current status of the project, the sources of project funding, and the extent to which the project was incremental (would not have been undertaken without STDF or AGAR funding). The respondents were generally representative of the total population of funded projects in terms of type of proponent and sector.

- Interviews were conducted with proponents and other representatives associated with 96 projects which were identified as having led to the commercialization of a new product or process. Through these interviews, we were able to obtain data on the magnitude of the commercial impacts, identify the extent to which these impacts were attributable to the Science Council-funded project, and the extent to which they were incremental (would not have been realized without AGAR or STDF funding).

- Mini-case studies were conducted to further define or verify the reported benefits arising from 10 projects, including the 5 projects which, based upon the responses provided by the proponents, generated the greatest economic benefits of all projects funded under AGAR or STDF and 5 projects which involve new processes that have broad industry application.

- 50 telephone interviews were conducted with proponents of rejected applications and 19 interviews were conducted with proponents of projects which would have been eligible by did not apply for funding in order to obtain additional information on program incrementality, future demand for this type of program, and program modifications that would be required to accommodate these projects.

We then analyzed the information to determine the incremental impacts and effects generated by AGAR and STDF, and developed conclusions and recommendations regarding the program structure and delivery mechanisms.

Table II

PROFILE OF AGAR, STDF AND STDF-AGAR AWARDS, 1979-1990

	AGAR	STDF	STDF-AGAR	All Programs
Number of Competitions	20	1	3	24
Grants Awarded ($ million)	$36.9	$8.3	$19.2	$64.4
Value of Applications ($ million)	$145.9	$101.2	$60.5	$307.6
% Approved	25.2%	8.2%	31.8%	20.9%
Number of Projects Approved	740[1]	78	293	1,111
Number of Applications Received	2,056	472	657	3,185
% Approved	36.0%	16.5%	44.6%	34.9%
Average Value of Grant	$49,769	$106,949	$65,771	$ 58,004
Average Value of Application	$70,958	$337,807	$92,125	$114,870
Reduction in Commitments[2] (million)	$1.6	$0.4	$0.2	$2.2
% of Grants Awarded	4.3%	4.3%	1.7%	3.4%
Awards by Grant Recipient:				
Private Sector	46.7%	65.2%	64.7%	54.5%
Universities and Colleges	45.6	24.8	32.8	39.1
Not-For-Profit Organizations	7.7	10.0	2.5	6.4
	100.0%	100.0%	100.0%	100.0%
Grants Awarded by Sector:				
Agriculture and Food	7.4%	4.0%	3.9%	5.9%
Aquatic Resources	16.6	4.9	10.0	13.1
Bio-technology	0.9	4.1	5.2	2.6
Computers and Computing	5.8	16.0	10.3	8.5
Electronics and Communications	18.7	23.4	18.8	19.3
Energy	8.7	6.7	5.1	7.4
Environmental Technology	0.0	0.0	5.2	1.6
Forestry and Forestry Products	23.5	11.7	19.4	20.7
Health Technology	0.0	7.8	7.5	3.2
Manufacturing and Machinery	10.1	14.2	9.8	10.5
Mining, Minerals, and Metals	7.0	7.2	4.9	6.4
Transportation	1.3	0.0	0.0	0.7
Total	100.0%	100.0%	100.0%	100.0%
Grants Awarded by Type of Project:				
New Project	59.8%	100.0%	73.9%	69.0%
Renewal	40.2%	0.0%	26.1%	31.0%
Total	100.0%	100.0%	100.0%	100.0%

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[1] An additional 15 projects were funded under AGAR prior to the establishment of the first competition (RC-1).

[2] Includes refunds and awards which were declined. Reductions in commitments for STDF-AGAR relate only to the SA-1 competition.

PROFILE OF PROJECTS FUNDED UNDER AGAR AND STDF

A profile of the projects which have been funded under the AGAR and STDF programs is provided below:

1. **Under the AGAR and STDF programs, $45.2 million in funding was awarded under 833 grants approved for 527 distinct projects and to 401 different proponents.**

   Table II presents a profile of the financial assistance awarded under the AGAR and STDF programs. Although not the focus of this evaluation, a profile of funding under the amalgamated program AGAR-STDF is also provided for comparison purposes. In total, 755 grants were awarded under AGAR (including 15 which were awarded before establishment of the competition system) and 78 grants were awarded under STDF. These grants were awarded for 527 distinct projects and to 401 different proponents (88 proponents received funding for more than one project). Only about 3.4% of the grants awarded have been declined or not fully taken up by the recipient.

2. **Funding under AGAR, STDF, and STDF-AGAR has been distributed to a wide variety of economic sectors.**

   As indicated in Table II, the Forestry and Forest Products, and Electronics and Communications have been the leading sectors, receiving about 40% of the grant funding. In reviewing funding by sector, the reader should keep in mind that the committee structure has changed over time and that not all committees have been in existence in each of the 11 years since the AGAR program was introduced in 1979.

3. **Of the 401 proponents who received funding under AGAR or STDF, 181 were associated with universities and colleges, 189 with private sector businesses, and 31 with non-profit organizations.**

   Of the 181 proponents associated with universities and colleges, 135 (75%) were associated with the University of British Columbia. Of the private sector proponents, 61% were drawn from organizations with fewer than 20 employees and 64% were drawn from businesses with annual revenues of less than $1,000,000.

4. **The application approval rate for the AGAR and STDF programs averaged 36.0% and 16.5% respectively.**

   The approval rate has been much higher for renewal projects (estimated at 95%) than for new projects (approval rate of 26%).

5. **The STDF and AGAR projects have been heavily concentrated in the Lower Mainland/Southwest and, to a lesser extent, the Vancouver Island/Coast Development Regions.**

   Based upon the address of the proponent, it is estimated that over 85% of the STDF and AGAR funding has been awarded to organizations in the Lower Mainland/Southwest Development Region and 14% has been awarded to organizations in the Vancouver Island/Coast Development Region.

6. **Salaries have comprised an estimated 64% of the reported expenditures of projects funded STDF and AGAR.**

   Proponents are required to report quarterly on their project expenditures[1]. Almost two-thirds (64.1%) of reported expenditures related to wages and salaries, 14.7% related to the purchase of equipment, and 10.3% related to the purchase of materials. Other leading types of expenditures including overhead, travel, and computer costs. If we assume that 64% of the Science Council funding has been applied to wages and salaries, then the AGAR and STDF programs directly funded $29.0 million in wages and benefits based upon the total approved funding of $45.2 million.

7. **It is estimated that, on average, over 2 years of employment per project were paid for out of total project costs.**

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[1] It should be noted that these figures are based upon reported expenditures, which are not necessarily equal to total project expenditures. The proponent may have incurred research and development costs prior to, during, or after completion of the AGAR or STDF project which were not reported to the Science Council.

According to the 300 respondents to our project specific questionnaire, the average project involved 28.7 person months of project-related employment (one person month of employment equals one person employed for one month). Assuming that the average employment created during all projects which received funding under AGAR or STDF was 28.7 person months, the AGAR and STDF programs supported over 15,000 person months in project-related employment.

MAJOR FINDINGS AND CONCLUSIONS

The major findings and conclusions arising from our evaluation of the AGAR and STDF programs are as follows:

1. **The STDF and AGAR programs have stimulated substantial incremental investment in research and development.**

   Based upon the survey results, it is estimated that the AGAR and STDF funding represented, on average, 32.4% of the total costs of applied research and development projects which received funding from the Science Council. It is estimated that 45% of the amount invested from other sources, or approximately $42 million, were incremental in that the funds would not have been invested in the projects in the absence of AGAR or STDF funding.

   In addition to the original research project, over 60% of the proponents surveyed indicated that the results of the Science Council funded project stimulated further research and development directly related to the technology. The incremental investment in additional research undertaken by the proponent organization is conservatively estimated at over $26 million.

2. **This research and development has been associated with the commercialization of at least 99 products and processes to date.**

   Through in-depth interviews with proponents and by undertaking 10 mini-case studies, we were able to obtain detailed information on the commercial impacts of 96 of these products and processes. In addition to these commercialized products and processes, our survey

identified a further 33 products and processes which are now in their final stages of development and will likely be commercialized in the next 2 to 3 years.

3. **Commercialization of these products and processes has stimulated significant incremental economic impacts.**

The economic impacts arising from commercialization of these 96 products and processes have been very substantial. However, not all of these impacts can be credited to the Science Council funding because, in many instances, it is possible that the product or process could have been commercialized even if the project had not been undertaken, or that the project could have been undertaken without Science Council funding. Based upon the survey results, it is estimated that about 65% of the economic benefits generated to date by the Science Council funded projects were truly incremental in that they would not have occurred in the absence of Science Council funding. This result is believed to be slightly above average for a program of this nature.

The incremental commercial impacts generated to date by these 96 products and processes include (all dollar figures are expressed in 1991 dollars):

- Cumulative revenues and cost savings of $83 million. Over 70% of the revenues are derived from export sales. If we assume that the survey has quantified 80% of the actual benefits to date, the incremental revenues and costs savings would be equal to $1.70 per dollar contributed under AGAR or STDF[2]. In calculating the average return, the amount of funding provided under AGAR and STDF has also been expressed in 1991 dollars using the CPI.

  In addition, a further $116 million in incremental revenues and cost savings is projected to be generated by these 96 products and processes between

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[2] Within the body of this report, the economic impacts (per dollar of funding contributed) of the STDF and AGAR programs are reported in terms of a range. The lower limit is based on the assumption that our sample of 300 projects captured all the projects commercialized to date. The upper limit assumed that an equal proportion of benefits was generated by projects not included in our sample of 300. Because the commercialized projects were identified through a variety of sources, we believe that the first case scenario is closer to the actual value than the second. For the purposes of this summary and Table III, we have assumed that the evaluation has quantified 80% of the actual benefits to date.

Table III

SUMMARY OF INCREMENTAL RETURNS GENERATED PER DOLLAR OF SCIENCE COUNCIL FUNDING PROVIDED (1)

Type of Proponent	Revenues To Date	Revenues To the Year 2000	Capital Investment	Person Years
Industry	$ 2.64	$ 6.73	$ 0.11	2.33
University	0.89	1.66	0.04	1.06
Non-Profit	0.41	0.98	1.41	1.39
All Types	$ 1.70	$ 4.08	$ 0.19	1.71

Source: Survey of proponents of 96 commercialized projects

Note (1): Based on assumption that the evaluation quantified 80% of the economic impacts to date. All returns are expressed per dollar of funding provided, except for person years of employment which are expressed per $100,000 of funding provided.

1992 and the year 2000. The projected revenues have been discounted back to 1991 at the rate of 20% per annum in order to reflect inflation and the level of risk associated with such long-term projections.

- Incremental capital investments, subsequent to the project, totalling about $9.2 million (equal to $0.19 per dollar contributed under AGAR or STDF assuming that the survey has quantified 80% of the actual benefits to date). The impact on capital investment is relatively limited because, in many instances, the proponent's organization either already owned most of the equipment required to manufacture the product/process or entered into production and marketing agreements with third party organizations, thus limiting the amount of equal capital invested.

- The creation or maintenance of about 227 employment positions involving 830 person-years of employment (one person year of employment equals one person employed for one year). If we assume that the survey has quantified 80% of the actual employment benefits to date, approximately 1.71 person years of employment have been created for every $100,000 in funding contributed under AGAR and STDF.

In addition to these direct impacts, at least 57 of the 96 commercialized products and processes have also had an economic impact on other B.C. based organizations. For at least five projects, which were the focus of case studies, the magnitude of these impacts was very substantial.

4. **Projects sponsored by industry (private sector) proponents have provided the greatest return to date per dollar of Science Council funding provided.**

For example, if we assume that the survey has quantified 80% of the actual benefits to date, industry projects have generated average incremental revenues and costs savings to date of $2.64 per dollar contributed under AGAR or STDF as compared to an average of $0.89 for projects sponsored by proponents associated with universities and colleges as indicated in Table III.

5. **The Science Council funding programs for applied research and development have also had a number of significant intangible impacts.**

A number of Science Council funded projects have generated significant intangible benefits which, while difficult to measure, probably exceed their direct tangible economic impacts. As an illustration:

- 31% of the proponents surveyed indicated that their project had a "major" impact on their organization's willingness to invest in research and development.
- 44% of the proponents surveyed indicated that their project had a "major" impact on their organization's research capabilities.
- 36% of the proponents surveyed indicated that their project had a "major" impact in terms of promoting cooperation between their organization and others with respect to development of the product or process.

In addition, Science Council funded projects have contributed to a greater awareness of the Science Council, raised the profile of research and development in B.C., and benefited the general public through environmental, health and safety improvements.

6. **The need for further research was identified as the major constraint to commercialization for projects not yet commercialized.**

Applied research and development is an inherently risky activity in that it is expected that the majority of projects will not lead to the commercialization of new products or processes. For investors. the inducement to invest in applied research and development is that the potential return is sufficient to justify accepting the level of risk involved. This pattern has proven to be true with respect to the Science Council funding. Although the economic benefits generated by the 99 commercialized products and processes have been more than sufficient to justify the costs of the program, less than one-third of the projects have led to commercialization to date or are projected to be commercialized in the next two to three years. Of the remaining projects, approximately one-half (47.5%) require further research before the results can be commercialized, often because of unforseen technical difficulties. Other leading constraints to commercialization which were identified include that the funding necessary for commercialization is not available, the proponent organization does not have the technical or business capabilities required to directly implement the results, and a market sufficient to warrant commercialization has not been identified.

7. **While there are a variety of other Federal and Provincial Government programs which may provide funding for applied research and development, the level of duplication or overlap has been minimized through a high degree of interaction between the Science Council and Federal Government departments and agencies and Government of B.C. ministries and agencies.**

   For example, the Peer Review Committees of the Science Council draw representatives from 7 agencies and departments of the Federal Government and 5 ministries of the Provincial Government. In addition, representatives of the Science Council are members of the review committees established for NSERC and IRAP-M which are the two programs which are most similar to Technology B.C. in terms of focus and client group. Project funding from the Science Council was often complemented by funding from other programs including, most notably, NSERC, IRAP, and FIRDA.

8. **The Science Council of B.C. has proven to be a very effective mechanism for delivering programs which provide financial assistance for applied research and development.**

   The major strengths of the delivery system are as follows:

   - Through the Peer Review Committee system, a wide variety of representatives from government, industry and academia have provided input into the selection of projects.

   - Awareness of Technology B.C. appears to be relatively high, particularly amongst research organizations located in the Lower Mainland and in Victoria.

- The majority of proponents rated program features such as the availability of information on the program, suitability of the eligibility requirements, clarity of the program guidelines, availability of advice upon applying to the program, and length of time between project approval and receipt of funds as satisfactory or better. In particular, the awards officers were praised by proponents for being of assistance during the application process as well as during implementation of the project.

  There was some concern expressed with respect to the reporting requirements (particularly amongst proponents associated with universities and colleges) and the length of time required for approval (particularly amongst private sector proponents), although the majority of proponents who expressed an opinion still found these features to be satisfactory. There were very few instances where the economic impacts generated by a project were constrained by program features such as the reporting requirements or the length of time required for approval.

- The majority of the Peer Review Committee members surveyed indicated that the eligibility criteria and funding guidelines established for the Technology B.C. programs are appropriate. However, there was support for increasing flexibility with respect to the allocation of funding between core research and industry based research, the definition of eligible project costs, and the proportion of total project costs for industry based research that must be funded by the proponent. In addition, it was recommended that the Science Council provide greater assistance to small and medium sized businesses in preparing proposals for funding.

- The Science Council represents a very cost-effective mechanism for delivering the Technology B.C. program. The cost of administration, expressed as a percent of the value of grants awarded, declined from 5.8% in 1986-87 to 4.6% in 1990-91. By comparison, the average administration cost for most grant programs we have evaluated in the past has ranged from 10% to 15% of the value of the grants awarded. The volunteer system of Peer Review Committees is a major contributing factor to the cost-effectiveness of the delivery system.

9. **The effectiveness of AGAR and STDF in stimulating economic development does not appear to have been impaired by the limited number of large grants which have been awarded.**

Few large grants (over $150,000) have been awarded under the Science Council programs. However, no empirical data arises from the evaluation which suggests that the effectiveness of the applied research and development funding programs has been impaired by the limited number of large grants which have been awarded. In fact, many of the representatives we surveyed expressed the opinion that funding a large number of small projects was likely more effective in terms of promoting economic development and diversification than funding a few large projects.

10. **The need for financial assistance which supports applied research and development in B.C. is projected to remain strong.**

Because of the level of risk associated with applied research and development, it is very difficult for organizations to obtain funding for research from traditional debt and equity financing sources. Programs, such as AGAR and STDF, play a very important role in filling this financing gap thereby enabling B.C. companies to develop and commercialize new products and processes. According to most of the program, government and industry representatives surveyed, the need for financial assistance programs such as Technology B.C. which provide funding for applied research and development has increased over the past 3 to 5 years. It is widely recognized that a strong commitment to research and development is required if B.C. is to continue to compete successfully in an increasingly competitive global-based economy.

In addition, the demand for funding is continuing to increase. The infrastructure for applied research and development in B.C. has further developed over the past five years and, consequently, there are now more individuals and organizations competing for funding. The majority of the proponents, responding to our survey, who received funding under AGAR or STDF indicated that they are "likely" or "extremely likely" to apply to the Science Council for applied research and development grant funding over the next few years.

RECOMMENDATIONS

The major recommendations arising from our review of the Science Council programs which have provided financial assistance for applied research and development are as follows:

1. **The Government of B.C. should continue to provide significant financial support for programs such as Technology B.C. which provide financial assistance for applied research and development.**

   The results of this evaluation indicate that the AGAR and STDF programs have been successful in directly stimulating $42 million in research and development activity and another $26 million in subsequent research and development. The products and processes developed as a result of this activity have generated incremental revenues of over $83 million and over 800 person years of employment. The impacts of the projects funded under AGAR and STDF will continue to increase as 75 of the products and processes are still being marketed and a further 33 are expected to be commercialized within the next two to three years. The programs have also generated important indirect and intangible benefits which enhance B.C.'s ability to compete in a globally based-economy.

2. **In order to generate the greatest return per dollar contributed in the short-term, highest priority should continue to be given to industry based projects in the allocation of funding.**

   Projects sponsored by industry (private sector) proponents have provided the greatest return to date per dollar of Science Council funding provided. For example, we estimate that industry-based projects have generated average incremental revenues and costs savings to date of $2.64 per dollar contributed under AGAR or STDF as compared to an average of $0.89 for projects sponsored by proponents associated with universities and colleges.

   It should be noted, however, that this evaluation may serve to under-estimate the impact of core research projects to the extent that such projects may require a longer period of time before commercialization can occur. In addition, the impacts of university-based research may be more wide spread and, therefore, difficult to measure than are the impacts of projects sponsored by a private sector organization.

3. **The Science Council should take steps to increase the number of applications received from private sector organizations.**

In order to increase the demand for funding amongst private sector organizations, it is recommended that:

- The Science Council should focus its promotional efforts more directly on private sector organizations.

  Given that awareness amongst potential applicants from non-profit organizations and universities and colleges can adequately be generated through word-of-mouth (particularly referrals from other members of the same organization), the primary focus of the formal promotional program should be on increasing awareness of the Technology B.C. program in the private sector. It would also be useful to establish a system to evaluate the effectiveness of the promotional program. For example, a database could be constructed to monitor the number of applications received by region and the number of applications received from applicants who have never applied to the Science Council for applied research and development funding in the past. In addition, a random survey could be conducted to estimate the level of awareness amongst industry representatives.

- The Science Council should make greater use of seminars, workshops and other face-to-face mediums to promote Technology B.C. to small and medium sized businesses.

  These seminars and workshops should be targeted not only at potential applicants, but also at potential intermediaries and referral sources such as regional economic development officers, industry associations, community colleges, and NRC Industrial Technology Advisors.

- Where the potential impacts are significant and the applicant does not have the necessary resources to undertake the project without additional financial assistance, the Peer Review Committees should have the option of recommending funding of more than 50% of the project costs.

- Greater assistance in the preparation of proposals should be made available to small and medium sized businesses.

  Concern was expressed by a number of Peer Review Committee members that potentially very useful research projects were not being funded because the proponents are not capable of preparing an adequate proposal. Such proponents could be dissuaded from applying to the program by the need to prepare a detailed proposal or be rejected because the quality of proposal was poor or it was incomplete technically. To ease this constraint, it was recommended that the Science Council conduct seminars and workshops to assist potential applicants in preparing applications, provide direct assistance in some situations, and establish a referral service through which potential applicants could be referred to individuals and organizations who could be of assistance in the preparation of proposals.

- The application form should be revised to make it less intimidating for small and medium sized businesses.

  The application form appears to be targeted at researchers from universities and colleges or from large research organizations and, therefore, may serve to discourage applicants from small and medium sized private sector organizations. The form should be rewritten with language and in a format which is more appropriate for small and medium sized businesses.

- Within the existing approval structure, and provided that the quality of the adjudication process is not affected, options to reduce the turn around time on applications should be examined.

The application review system is one of the major strengths of the Technology B.C. program. However, the length of time from submission to approval was identified by private sector respondents as a constraint to private sector applications.

4. **The Science Council should strive to establish a greater presence outside of the Lower Mainland and Victoria areas.**

A greater emphasis should be placed on creating awareness and encouraging applications from firms located outside of the Lower Mainland and Victoria. Over 85% of program funding has been awarded to organizations in the Lower Mainland and 99% has been awarded to organizations in the Lower Mainland or on Vancouver Island. In addition to targeting the interior through advertising, seminars and workshops, the Science Council should establish greater links with regional ITA's, regional development officers, and other potential referral agencies as well as with the regionalization initiative established within MAETT.

5. **Options should be considered to improve the effectiveness of the application review process with respect to the assessment of potential economic impacts.**

In general, a thorough review of applications is performed with respect to the scientific and technical merits, proponent capabilities and resources, and project budget and time frame. However, concerns have been raised regarding the review of the economic potential of proposed projects. In order to improve the review process with respect to assessment of economic potential, it is recommended that:

- A greater emphasis in the application should be placed on identification of the potential market, competition and commercial risks associated with the proposed product or process. In addition, a description of the specific steps that would be undertaken in moving the product or process from the research stage to commercialization should be provided. Most proposals do not contain a sufficient discussion of the size of the potential market and the competitive situation to enable Peer Review Committee members to assess the reasonability of the estimates of potential revenues, costs savings and employment provided.

- Where warranted by the size of the grant being considered and concerns regarding the economic potential, input should be obtained from at least one external reviewer regarding the market potential of the proposed product or process and the prospects for commercialization.

6. **Consideration should be given to providing unsuccessful applicants with more detailed information on the reasons leading to the rejection of their application.**

The current form letters used by the Science Council to communicate rejection provide very little specific information on the reasons leading to that decision. Because of the time involved in preparing and submitting an application, a number of Peer Review Committee members and proponents surveyed expressed concern that this policy may discourage unsuccessful applicants from applying again. Furthermore, that those deciding to re-apply are not given sufficient information to enable them to identify and correct the deficiencies of their initial application.

7. **Consideration should be given to introducing greater flexibility with respect to the program funding guidelines.**

While the general structure of the Technology B.C. program appears to be very appropriate and well designed, situations occasionally do arise where the objectives of the program may not be best served by following the funding guidelines. In particular, it is recommended that the Peer Review Committees be permitted greater flexibility with respect to the allocation of funding between core research and industry based research (for example, restating the guidelines in terms of a range), the definition of eligible project costs, and the proportion of total project costs for industry based research that must be funded by the proponent.

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I. INTRODUCTION

A. BACKGROUND

The Science Council of B.C. was formed in 1978 to advise the Government on scientific matters. It was also responsible for the administration of the Assistance Grants for Applied Research (AGAR) program, which awarded its first grant in 1979. Grants were awarded under the AGAR program to researchers in universities, colleges and institutes and private companies, up until 1989.

In 1988, the Science and Technology Development Fund (STDF) was implemented by the Ministry of Advanced Education, Training and Technology (MAETT). STDF funded a variety of programs such as Scientists in Schools, and the Premiers Advisory Council on Science and Technology (PACST). As well, STDF provided grants for applied research. The Science Council administered the dispensation of grants awarded under both AGAR and STDF in 1988.

In 1989, the AGAR Program and the STDF Program were amalgamated as STDF-AGAR. In 1991, the name of the program was changed from STDF-AGAR to Technology B.C.

B. PURPOSE OF STUDY

The purpose of the evaluation is to determine the effectiveness of the research assistance provided under the AGAR and STDF programs and develop recommendations to improve the current program design.

The specific objectives developed for the evaluation study are as follows:

1. Develop a historical profile of the programs in terms of expenditures, administration costs, and type of applicants.
2. Describe how the grants were leveraged using other sources of funds.
3. Estimate the impact of the AGAR and STDF programs on the research expenditures of recipients.

4. Estimate the primary economic and social benefits attributable to the program.

5. Develop recommendations designed to improve the program's impact on research activity and on the economy.

Evaluation of the AGAR and STDF programs was conducted in two phases. The purpose of the first phase was to develop an evaluation framework to guide implementation of the evaluation. Based upon this evaluation framework, a detailed evaluation of the AGAR and STDF programs was undertaken in the second phase of the study. This document represents the output of the second phase of the project.

C. METHOD OF STUDY

1. Preparation of the Evaluation Framework

In order to gain a thorough appreciation of the policy framework, scope and nature of STDF-AGAR, we reviewed the relevant program and policy documentation including program guidelines, application forms, instructions to peer review committee members, database summaries, annual reports of the Science Council of B.C., promotional materials, previous evaluations undertaken on the AGAR program, the final report prepared on the STDF program, and a discussion paper on merging the STDF and AGAR programs. We also reviewed the available published statistics and studies to obtain an overview of trends and highlights of science and technology research in B.C. and the rest of Canada. In addition, we interviewed a sample of government representatives with the Ministry of Advanced Education, Training and Technology and the Science Council of B.C. involved in the design, operation, and review of the programs.

Based upon this research, we refined the "logic" model for the STDF-AGAR program, finalized the evaluation issues, determined the most appropriate performance indicators, and identified sources of information for each indicator. We also prepared draft survey questionnaires and interview guides. The evaluation framework, draft survey questionnaires and interview guides were then approved by the Steering Committee established for the study.

Table 1.1

OVERVIEW OF THE SURVEY PROGRAM IN TERMS OF THE NUMBER OF INTERVIEWS AND QUESTIONNAIRES COMPLETED

Type of Respondent	Number
Program Representatives From Science Council	5
Peer Review Committee Members	87
Proponents of Completed Projects	
• General Questionnaire	219
• Project Specific Questionnaire	300
Proponents of Projects Leading to Commercialization	100
Mini-case Studies	30
Proponents of Withdrawn or Rejected Applications	50
Non-applicants	19
Representatives of Other Programs	10
	820

2. Evaluation

As indicated in Table 1.1, on the opposite page, 820 people were surveyed through personal and telephone interviews and mail questionnaires during the course of the second phase of the evaluation. A listing of representatives surveyed is provided in Appendix 1. A description of the methodology is provided in the following paragraphs.

a. Detailed Review of Project Files

In order to develop a profile of projects and proponents which received funding under AGAR and STDF, we undertook a detailed review of the project files maintained at the offices of the Science Council. The profile outlines the level of grant funding by:

- Year;
- Program (AGAR, STDF, STDF-AGAR);
- Type of proponent (academic, private sector, not-for-profit organization);
- Sector;
- New versus renewal projects;

In addition, the results of the file review were analyzed to determine the:

- The number of different proponents who have received grant funding;
- Breakdown of project expenditures between wages and salaries, materials, purchase of equipment, overhead, travel and computer expenses;
- Funding obtained from other sources;
- Distribution of funding on a regional basis;
- Characteristics of proponent companies in terms of sales and number of employees;
- The incidence of consortia (where more than one organization was active in implementing the project).

In addition, a review of files on rejected and withdrawn applications was conducted in order to summarize the reasons for rejection or withdrawal. We also conducted a review of information contained in the Science Council database.

b. Survey of Program Representatives

From this survey of 5 Science Council representatives, we obtained feedback regarding the impacts and effects of the programs, the perceived need for this type of programming, and the funding guidelines and application review process. With the assistance of the program representatives, we also identified the costs of the administrative structure and determined how those costs have changed over the past three years.

c. Survey of Peer Review Committee Members

The Science Council has established 12 Peer Review Committees, corresponding to the following functional areas:

- Agriculture and Food;
- Aquatic Resources;
- Biotechnology;
- Computers and Computing;
- Electronics and Communications;
- Energy;
- Environmental Technology and Waste Management;
- Forestry;
- Forest Products;
- Health Technology;
- Manufacturing and Machinery;
- Mining, Minerals, and Metals.

The function of the Peer Review Committees is to review and priorize project applications and develop recommendations regarding which projects should receive funding. The committees consist of volunteers and range in size from 9 members to 15 members.

The Peer Review Committee members were surveyed to determine their perceptions regarding the impacts and effects of the programs, the demand for funding, and the funding guidelines and application review process. A total of 141 questionnaires were distributed to committee members, of which 87 were completed and returned equivalent to a response rate of 62%. At least 5 questionnaires were returned from each of the Peer Review Committees.

d. Survey of Proponents of Completed Projects

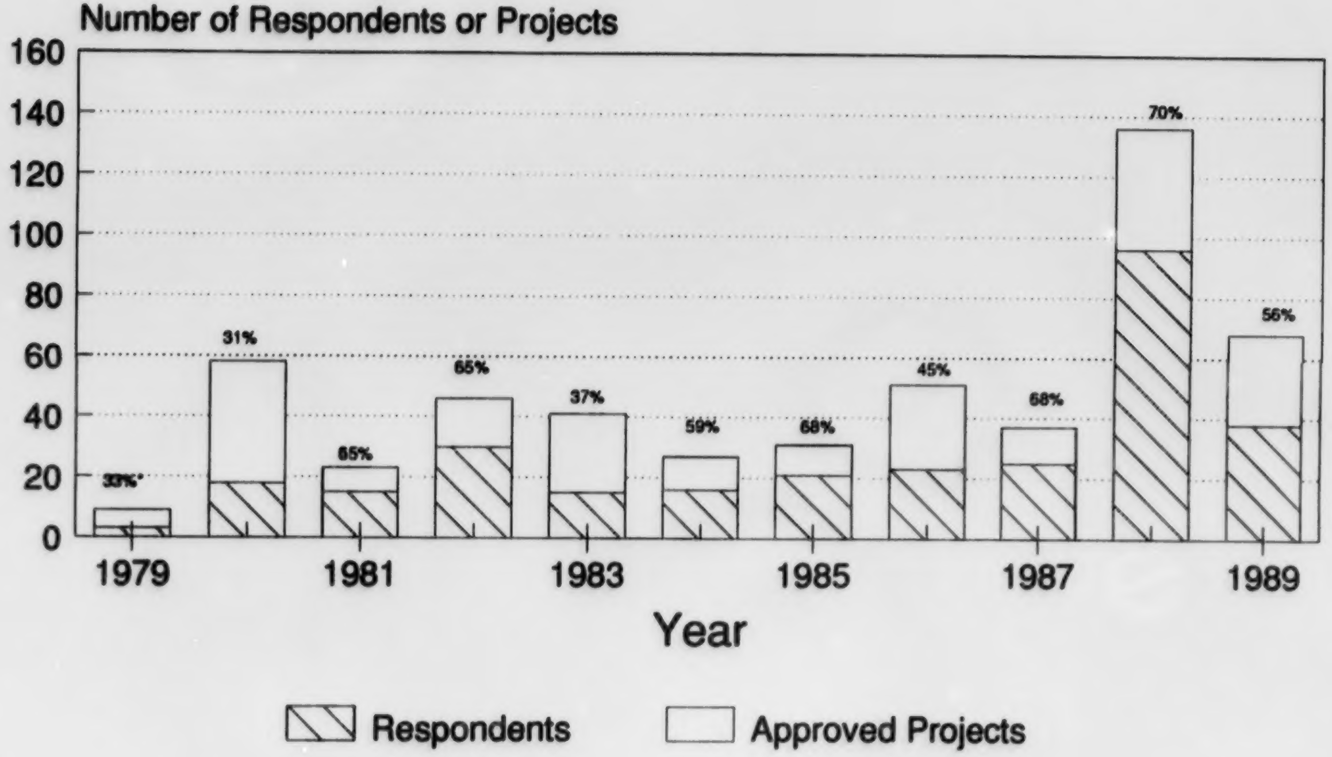
Questionnaires were distributed to proponents of all projects funded under STDF or AGAR. Projects funded under the amalgamated STDF-AGAR program were not targeted because it was felt that not enough time had elapsed since the conclusion of the project to assess the resulting impacts. Each proponent of an AGAR or STDF funded project was mailed a general questionnaire and a project specific questionnaire related to every project for which he or she received funding. Under STDF and AGAR, 401 proponents received 833 grants for 527 distinct projects. Therefore, 527 project specific questionnaires and 401 general questionnaires were mailed to the proponents. The purpose of the general questionnaire was to obtain feedback from the proponents regarding source of awareness of the programs, level of satisfaction, and future demand for funding. The purpose of the project specific questionnaire was to identify the outcomes and current status of the project, the sources of project funding, and the extent to which the project was incremental (would not have been undertaken without STDF or AGAR funding).

The initial mailing generated a response rate of approximately 30%. The low response rate can be attributed to the length of time that has elapsed since many of the projects were implemented, the low response rates typically associated with mail questionnaires, and the fact that many of the proponents participated in evaluations of the AGAR program in 1985 and 1987 and were somewhat resistant to providing further information. In order to improve the response rate, 50 proponents were contacted directly by telephone and a second copy of each questionnaire was distributed to an additional 75 proponents. The focus of the follow-up program was to improve the response rate amongst:

- Proponents of projects identified in the 1987 evaluation as having generated commercial benefits; and
- Proponents of projects which had received funding of over $100,000 since 1986.

Figure 1.1

RESPONSE RATE FOR PROJECT SPECIFIC QUESTIONNAIRE BY YEAR OF FUNDING



* - Response Rate (Respondents as a Percent of Approved Projects)

This follow-up program was successful in significantly improving the response rate. In total, 219 general questionnaires (a response rate of 55%) and 300 project specific questionnaires (a response rate of 57%) were returned.

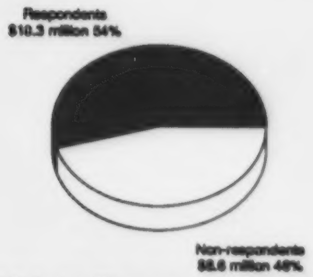
The profile of respondents to the project specific questionnaire was generally representative of the total population of projects approved under AGAR and STDF in terms of year of funding, type of proponent and sector as described below:

- Figure 1.1, on the opposite page, details the response rate to the project specific questionnaire by initial year of project funding. For example, a project specific questionnaire was completed and returned for 96 of the 136 new projects which were approved for funding under AGAR or STDF in 1988, equivalent to a response rate of 70%. As indicated in Figure 1.1, the response rate ranges from a low of 31% with respect to new projects approved in 1980 (a completed project specific questionnaire was returned for only 18 of the 58 new projects approved in 1980) to a high of 70% in 1988. Overall, the average response rate was 50% for projects approved prior to 1986 and 62% for projects approved from 1986 to 1989.

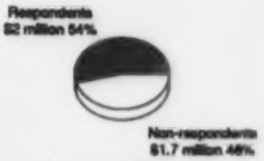
- A total $45.2 million in funding was awarded under STDF and AGAR, of which $22.6 million was awarded to proponents from the private sector, $18.9 million was awarded to proponents associated with universities and colleges, and $3.7 million was awarded to proponents associated with not-for-profit organizations. The 300 projects for which a project specific questionnaire was returned were awarded $23.2 million in funding from AGAR and STDF, representing 51% of the total funding awarded under these programs. In terms of the amount of funding awarded, the response rate to the project specific questionnaire did not vary significantly by type of proponent ranging from 48% amongst proponents in the private sector to 54% amongst proponents from universities and colleges and from not-for-profit organizations as indicated in Figure 1.2.

Figure 1.2

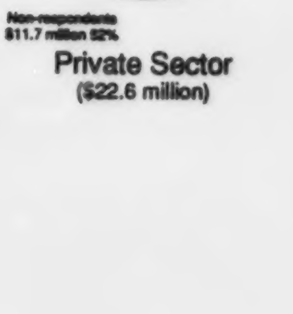
RESPONSE RATE FOR PROJECT SPECIFIC QUESTIONNAIRE BY TYPE OF PROPONENTS



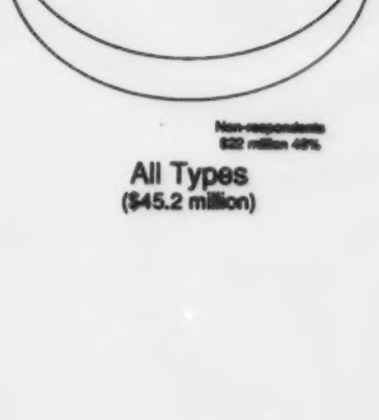
Universities and Colleges
($18.9 million)



Not-for-Profit
($3.7 million)



Private Sector
($22.6 million)



All Types
($45.2 million)

- Figure 1.3 compares the profile of respondents to the project specific questionnaire to the total population in terms of the level of funding awarded by sector. For example, of the $23.2 million in funding awarded to projects for which a project specific questionnaire was returned, 7% was awarded for projects reviewed by the Agriculture and Food Peer Review Committee. Therefore, in this respect, the respondents to our survey are directly representative of the total population in that 7% of the total funding approved under AGAR and STDF was awarded for projects reviewed by the Agriculture and Food Peer Review Committee. As indicated in Figure 1.3, the sectoral profile of respondents to our survey is generally representative of the total population of projects approved under AGAR and STDF. However, the forestry and forest products sector and the energy sector tend to be slightly over-represented in our survey while the aquatic resources, computers and computing, and mining, minerals and metals sectors tend to be slightly under-represented. It should be noted that the committee structure has evolved over time in response to changes in the number of applications received from each of the various sectors. For example, the Computers and Computing, Health Technology, and Biotechnology Peer Review Committees were all established after 1985. Furthermore, the Environmental Technology and Waste Management Peer Review Committee was not established until STDF and AGAR were amalgamated into a single program.

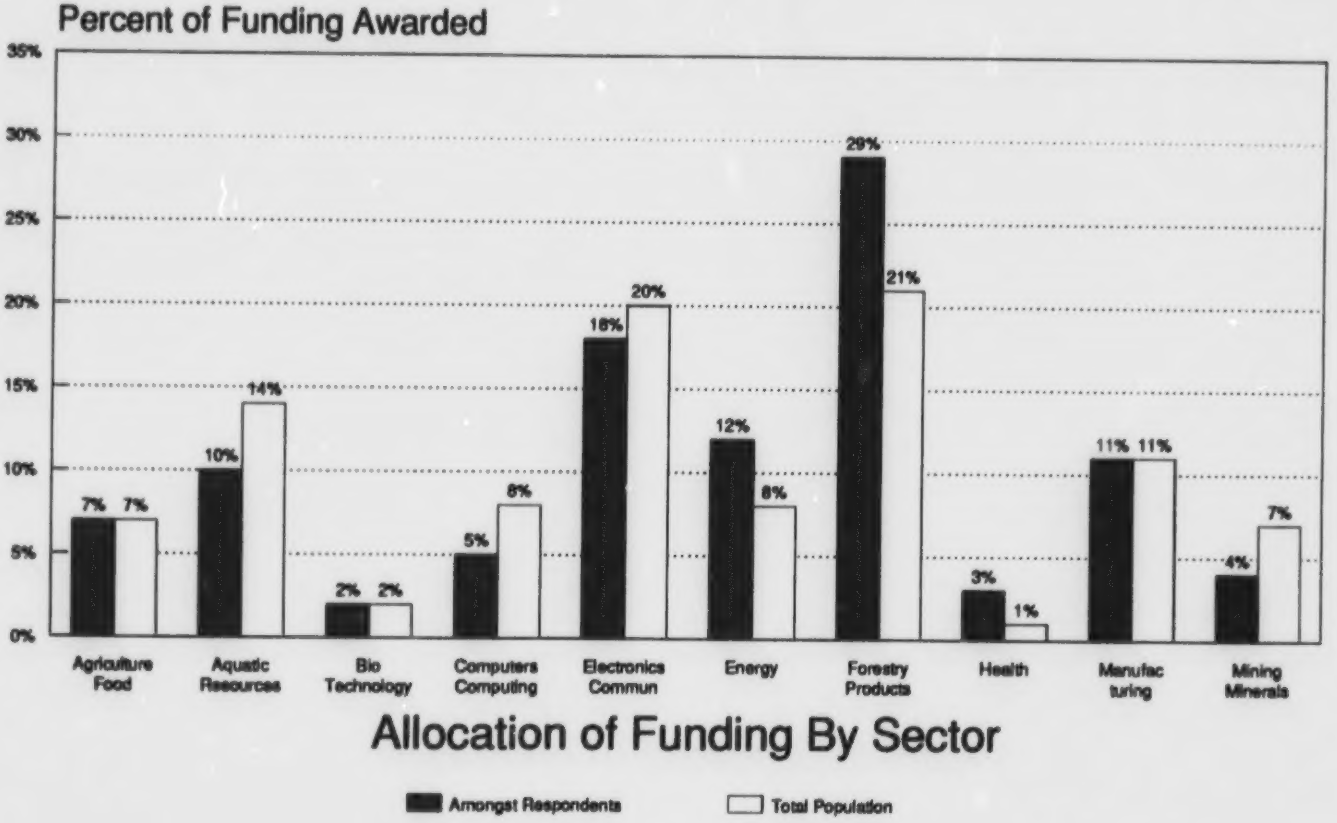
Of the 219 respondents to the general questionnaire, 98 (45%) are currently associated with universities and colleges, 94 (43%) are in the private sector, and 27 (12%) are associated with not-for-profit organizations. Of the 219 respondents, 122 received their initial award from the Science Council for applied research and development prior to 1987 while 97 respondents received their initial award in 1987, 1988, or 1989.

e. Survey of Representatives Associated with Projects Leading to Commercialization

Of the 527 projects funded under AGAR and STDF, 108 projects were identified as having led to commercialization. These included:

Figure 1.3

SECTORAL PROFILE OF RESPONDENTS VERSUS POPULATION IN TERMS OF FUNDING RECEIVED



- 58 projects which were identified through our project specific questionnaire (but which were not identified in the 1987 evaluation);
- 23 projects which were identified through the 1987 evaluation but for which a project specific questionnaire was not returned;
- 27 projects which were identified through our survey and in the 1987 evaluation.

These 108 projects were identified with 99 commercialized products or processes (in some instances, more than 1 project was associated with a single commercialized product or process). Through our interview program, we were able to obtain information on the commercial impacts of 96 of these products or processes, identify the importance of the Science Council-funded project in the process of commercialization, and estimate the extent to which the related AGAR or STDF funded project was incremental (would not have been undertaken without funding from AGAR or STDF).

f. Mini-case Studies

The purpose of the mini-case studies was to further define or verify the reported benefits arising from selected projects. The case studies were selected to include:

- The 5 projects which, based upon the responses provided by the proponents, generated the greatest economic benefits of all projects funded under AGAR or STDF. The purpose of the additional research was to check the reasonableness of the information provided by the proponent with respect to economic benefits and incrementality. Depending upon the nature of the project, this was done by surveying other people in the same organization, representatives of other organizations involved in the project, and government and industry representatives familiar with the product or process. At least one interview for each case study was conducted with a representative from outside the proposed organization.

- 5 projects which involve new processes that have broad industry application. Under AGAR and STDF, funding has been provided for projects which are designed to further develop a new process that will be applied by many organizations and operations, rather than by just the proponent. The purpose of these mini-case studies was to obtain an indication of the magnitude of the benefits generated by the projects. In order to do so, interviews were held with industry or government representatives who are familiar with the process, its use by industry in B.C., and the possible magnitude of the potential benefits generated through application of the process.

The results of the 5 mini-case studies related to processes with broad industry application are summarized in a short write-up contained in Chapter IV. The results of the other 5 mini-case studies were used to adjust the relevant proponent's responses with respect to incrementality and economic benefits; however, the results are not specifically detailed in the report in order to maintain proponent confidentiality.

g. Survey of Proponents of Withdrawn or Rejected Applications

Fifty telephone interviews were conducted with proponents of withdrawn and rejected applications in order to obtain additional information on program incrementality, future demand for this type of program, and program modifications that would be required to accommodate these projects. We also determined if the rejected or withdrawn research projects had actually proceeded without AGAR or STDF funding. Of the 50 representatives surveyed, 23 were drawn from the private sector while 27 were drawn from universities and colleges. The applications were rejected or withdrawn from Science Council competitions staged between 1987 and 1991.

h. Survey of Non-applicants

Nineteen telephone interviews were held with representatives from private sector organizations which have applied to AGAR or STDF in the past but have not applied to the program in recent years as well as with representatives from organizations which have received funding from other programs such as NSERC, IRAP, or under one of the

Economic Regional Development Sub-Agreements. Of the 19 respondents, 9 had applied to the Science Council for funding at some time in the past while 10 had never applied to the Science Council. All of the respondents has undertaken an applied research and development project over the past 3 years. The purpose of these interviews was to obtain additional information on the demand for program funding and the incrementality of the STDF/AGAR programs. Non-applicants were surveyed to identify the sources of funding employed, the reasons for not applying to STDF or AGAR, and the demand for future funding.

i. Survey of Representatives of Other Programs

In order to determine the extent to which the programs complement, duplicate, overlap or work at cross purposes to other federal and provincial programs in B.C., we conducted a survey of representatives of other programs which provide funding for research and development. In addition, we also contacted representatives from a sample of similar programs in other provinces.

We then analyzed the information to determine the incremental impacts and effects generated by AGAR and STDF, and developed conclusions and recommendations regarding the program structure and delivery mechanisms.

D. STRUCTURE OF REPORT

The following chapter provides a brief profile of the AGAR, STDF, and AGAR-STDF programs in terms of their objectives, program structure, activities to date, and administrative structure. Chapter III presents the findings of the evaluation with respect to program rationale issues, while Chapter IV outlines the major impacts and effects arising from the projects which received funding. Chapter V addresses the evaluation issues related to program delivery. The final chapter, Chapter VII, outlines the major conclusions and recommendations arising from the study.

II. DESCRIPTION OF THE STDF-AGAR PROGRAM

This chapter provides a brief description of the STDF-AGAR Program in terms of its history, objectives, program structure, activities to date, administrative structure, and project review and administration process.

A. HISTORY

The Science Council of British Columbia was formed in 1978 to advise the Government of B.C. on scientific matters. Shortly after being established, the Science Council identified a need for a program which would provide funding to encourage scientific and technological research in British Columbia in a manner that would create greater linkages between research organizations (particularly universities) and businesses who could apply the findings of the research. With core funding from the Government of British Columbia, the Science Council established the Assistance Grants for Applied Research (AGAR) Program in 1979. Grants were made from the AGAR program to researchers in universities, colleges and institutes and private companies until 1989. Over this period of ten years, 20 competitions were held and $36.8 million dollars in grants were awarded under AGAR.

In 1988, the Science and Technology Development Fund (STDF) was established by the Ministry of Advanced Education and Job Training and the Ministry for Science and Technology. The STDF was used to fund a variety of programs such as Scientists in Schools, Public Awareness, the Premier's Advisory Council on Science and Technology (PACST), and the STDF Competition. The STDF Competition provided grant funding for major single-year applied research projects, as a complement to the longer-term assistance available under AGAR. A budget of $10 million was established for the STDF Competition, of which $2 million was transferred to the Science Council for disbursement through AGAR. The remaining funds were used to support a research grant competition which was held in October, 1988.

The STDF Competition was promoted directly by the Ministry of Advanced Education and Job Training. Although formal approval of the grant applications remained with the Ministry, the services of the Science Council of B.C. were contracted to administer the STDF Competition. The administrative activities of the Science Council included evaluating and recommending projects for approval, processing payments to grant recipients, and monitoring project performance.

In 1989, the decision was made to the amalgamate the AGAR and STDF programs into one program known as STDF-AGAR. Some of the reasons for the amalgamation included:

- The two programs, AGAR and STDF, were relatively similar in purpose and structure;
- The existence of two similar programs, each funded and administered by the same two bodies, created confusion amongst the target groups as to which program they should apply;
- The amalgamation of the two programs served to streamline the application review process and ease the work load of the volunteer peer review committees;
- The amalgamation also provided opportunities for economies of scale with respect to program promotion and administration.

Beginning with the first competition held in November 1989, 3 STDF-AGAR competitions were held under which $19.3 million in grants were awarded. Commencing with the May, 1991 competition, the name of the amalgamated program was changed to Technology B.C.

B. OBJECTIVES

The objectives of the STDF-AGAR, STDF, and AGAR programs were similar in that each program focused on encouraging applied scientific and technological research which will promote further economic development in British Columbia.

The stated objective of the STDF-AGAR program is:

> *"To stimulate the development of science and technology which will promote economic expansion in the province."*

The stated objective of the STDF program was:

> *"To support single year projects which will stimulate the application of science and technology for the economic development of British Columbia."*

The stated objective of the original AGAR program was:

> *"To support research and development in natural, economic, social and applied sciences in B.C. industries, universities, applied research institutes and governmental departments to stimulate the application of knowledge and technology to increase the rate of economic and social development in the province."*

C. PROGRAM STRUCTURE

A brief description of the structure and guidelines of the STDF-AGAR program is provided in the following paragraphs. In addition, this section outlines some of the differences between the STDF-AGAR program and the former AGAR and STDF programs.

1. Sub-programs

STDF-AGAR encompasses two sub-programs, each of which is described below:

a. Industry Based Research and Development Program

The purpose of this program is to act as a stimulant to private sector companies for increased research and development activities. It is anticipated that the proponent will receive the primary financial benefit in the form of development of products or processes which will provide economic returns to the company. The industry research may involve research and development related to:

i. Products and Processes

Including proof-of-concept research, research and development of new products and processes, and prototype demonstration and evaluation projects.

ii. Technology Transfer

Including the application of new or existing technology from an external source to solve an identified industrial need or problem in a product or process, or the development or exploitation of new or existing technology from an external source to produce a new or improved commercially viable product or process.

Guidelines of the Industry Based Research and Development Program include:

- Applicants must be private companies operating in B.C;
- Post-secondary institutions and not-for-profit research organizations may only participate as collaborators or sub-contractors;
- Projects can be supported at a level that is normally up to 50% of the eligible costs;
- Support can be provided up to 3 years for proof-of-concept research, up to 2 years for development of products and processes, and up to 1 year for prototype demonstration and technology transfer projects.

b. Core Research Program

The purpose of this program is to fund projects that are at the strategic research, or proof-of-concept stage of development and that will have sector-wide benefits. Guidelines of the Core Research Program include:

- Only 30% of the STDF-AGAR grants can be contributed to projects funded under this program;
- Projects can be supported up to three years at a level up to 100% of eligible costs;

- The results of projects must be made available for distribution to all interested parties. In the proposal, the applicant must outline a mechanism whereby the results will be disseminated to potential B.C. users;
- Applicants must be post-secondary institutions, not-for-profit agencies or research consortia involving a group of unrelated companies.

2. General Guidelines

In addition to the program specific guidelines outlined above, there are a number of general funding guidelines which are common to both STDF-AGAR programs. These include:

- The STDF-AGAR program is intended to support applied research and development, not basic research.
- Project results must enhance resource based industries and/or the growth of advanced technology industries.
- All proposals must demonstrate industrial relevance and must be project-based, with specific, identified results.
- Proposals which demonstrate collaboration between industry and provincial post-secondary institutions are encouraged.
- Projects may take more than one year to complete, but only one year of funding will be approved at a time. The proponent must reapply for funding in subsequent years.
- A single applicant may not receive more than one new award per fiscal year or more than one grant (new and renewal) in the same competition;
- No more than 40% (target 33%) of funding in any year can be devoted to project renewals;

- Total support of new and renewal awards for an organization cannot exceed 10% of its research budget, where more than one award is held concurrently;

- Applicants need not apply to STDF-AGAR for funding prior to initiating a project, but may request funding at any point during the research and development cycle. However, the grant may not be applied to any cost incurred prior to receiving written notification of the award.

- The proportion of funding allocated to each area (economic sector) is established according to the following formula:

    - 70% of the funds will be allocated to each area in proportion to the value of requests (applications) received in each area; and

    - 30% of the funds will be allocated according to project priorities identified by the Science and Technology Grants Committee.

3. Comparison to AGAR

In comparison to the AGAR program, STDF-AGAR is considerably less flexible with respect to funding options. For example, under AGAR:

- There was no formal differentiation between industry-based and core research programs. As such, funding for core research projects was not limited to 30% of total grants.

- Private sector companies, who would be the prime beneficiary of the research, were not normally required to fund at least 50% of the project costs.

- There was no limit with respect to the proportion of funding granted to new versus renewal projects.

Table 2.1

SUMMARY OF AGAR, STDF, AND STDF-AGAR GRANT AWARDS BY YEAR ($000)

Year	Value of Grants Awarded			Grants Requested	Percent Approved
	Spring	Fall	Total		
1979	-	$1,530.6	$1,530.6	$12,180.0	12.6%
1980	$1,662.2	1,505.8	3,168.0	15,701.6	20.2
1981	2,414.3	2,362.1	4,776.4	14,643.5	32.6
1982	1,333.8	3,378.1	4,711.9	15,644.3	30.1
1983	1,581.0	1,809.4	3,390.4	12,567.5	27.0
1984	1,112.0	1,704.2	2,816.2	10,271.5	27.4
1985	1,448.0	1,762.6	3,210.6	13,547.4	23.7
1986	1,481.2	1,439.7	2,920.9	12,588.9	23.2
1987	1,345.5	2,071.5	3,417.0	12,321.4	27.7
1988	1,691.6	10,676.7[1]	12,368.3	118,572.6	10.4
1989	2,860.2	8,721.8	11,582.0	39,991.6	29.0
1990	3,629.7	6,919.5	10,549.2	29,581.0	35.7
Total			$64,441.5	$307,611.3	20.9%

---

[1] Including both the AGAR competition held in the fall of 1988 and the STDF Competition.

- Proprietary projects undertaken by post-secondary institutions and not-for-profit research organizations were eligible for funding.

In addition, under STDF-AGAR, a greater focus has been placed upon the potential economic benefits generated by project in the short-term. Although projects can be funded to a maximum of 6 years (3 years under the Core Research Program and 3 years under the Industry-Based Program), most will receive funding for less than three years.

4. Comparison to STDF

Although the administrative structure of the STDF-AGAR program closely reflects that which evolved under AGAR, the program structure, funding guidelines, and selection criteria are based primarily upon those developed for STDF. The major difference is that STDF supported single year projects, while the time-frame for STDF-AGAR has been expanded to up to 3 years for each sub-program.

D. ACTIVITIES TO DATE

A profile of the grants awarded by the AGAR, STDF, and STDF-AGAR programs is provided in the following paragraphs.

1. Grant Funding By Year

Table 2.1, on the opposite page, provides an annual summary of the value of grants awarded by the AGAR, STDF, and STDF-AGAR programs. As indicated, the value of grants awarded declined from a high of almost $5 million in 1981 to an average of approximately $3 million from 1983 to 1987. However, the staging of the STDF Competition in the fall of 1988 resulted in an almost four-fold increase in the value of the grants awarded. The value of the grants has exceeded $10 million during each of the past three years.

With the exception of 1988, the approval rate for grant applications has averaged approximately 28%. The approval rate in 1988 was only 10% as indicated in Table 2.1. The low approval rate in that year reflects the significant impact of the STDF Competition which attracted $106 million in applications. It is interesting to note that the approval rate of 35.7% in 1990 is the highest

TABLE 2.2

PROFILE OF AGAR, STDF AND STDF-AGAR AWARDS, 1979-1990

	AGAR	STDF	STDF-AGAR	All Programs
Number of Competitions	20	1	3	24
Grants Awarded ($ million)	$36.9	$8.3	$19.2	$64.4
Value of Applications ($ million)	$145.9	$101.2	$60.5	$307.6
% Approved	25.2%	8.2%	31.8%	20.9%
Number of Projects Approved	740[1]	78	293	1,111
Number of Applications Received	2,056	472	657	3,185
% Approved	36.0%	16.5%	44.6%	34.9%
Average Value of Grant	$49,769	$106,949	$65,771	$ 58,004
Average Value of Application	$70,958	$337,807	$92,125	$114,870
Reduction in Commitments[2] (million)	$1.6	$0.4	$0.2	$2.2
% of Grants Awarded	4.3%	4.3%	1.7%	3.4%
Awards by Grant Recipient:				
Private Sector	46.7%	65.2%	64.7%	54.5%
Universities and Colleges	45.6	24.8	32.8	39.1
Not-For-Profit Organizations	7.7	10.0	2.5	6.4
	100.0%	100.0%	100.0%	100.0%
Grants Awarded by Sector:				
Agriculture and Food	7.4%	4.0%	3.9%	5.9%
Aquatic Resources	16.6	4.9	10.0	13.1
Bio-technology	0.9	4.1	5.2	2.6
Computers and Computing	5.8	16.0	10.3	8.5
Electronics and Communications	18.7	23.4	18.8	19.3
Energy	8.7	6.7	5.1	7.4
Environmental Technology	0.0	0.0	5.2	1.6
Forestry and Forestry Products	23.5	11.7	19.4	20.7
Health Technology	0.0	7.8	7.5	3.2
Manufacturing and Machinery	10.1	14.2	9.8	10.5
Mining, Minerals, and Metals	7.0	7.2	4.9	6.4
Transportation	1.3	0.0	0.0	0.7
Total	100.0%	100.0%	100.0%	100.0%
Grants Awarded by Type of Project:				
New Project	59.8%	100.0%	73.9%	69.0%
Renewal	40.2%	0.0%	26.1%	31.0%
Total	100.0%	100.0%	100.0%	100.0%

---

[1] - An additional 15 projects were funded under AGAR prior to the establishment of the first competition (RC-1).

[2] - Includes refunds and awards which were declined. Reductions in commitments for STDF-AGAR relate only to the SA-1 competition.

experienced in any year since the AGAR competitions were first introduced in 1979. As indicated in Table 2.1, the increase in the approval rate in 1990 over 1989 resulted from a decrease in the value of applications received (from approximately $40 million to $30 million) rather than from an increase in the value of grants awarded (in fact, the value of grants awarded also decreased from $11.6 million in 1989 to $10.5 million in 1990). It should be noted that this approval rate includes both new and renewal applications.

2. Grant Funding By Program

A detailed profile of the AGAR, STDF, and STDF-AGAR programs in provided in Table 2.2 on the opposite page. As indicated, the cumulative approval rate (as defined by the value of grants awarded as a percentage of the grants requested) varies from only 8.2% for the STDF Competition to 31.8% for the amalgamated program. Only about 3.4% of the grants awarded (excluded the latest two competitions for which figures are not yet final) have been declined or not fully taken up by the recipient.

In total, 1,111 projects have been approved equal to 35% of the 3,185 applications received. The approval rate for applications appears to be inversely related to the size of the application. As indicated in Table 2, the average value of grant is significantly lower than the average value of applications under all three programs. This suggests that either larger-sized projects are less likely to be funded or that the size of grant awarded per approved project tends to be smaller than the amount requested. Although there is no formal maximum grant per project, it has been noted that the desire of the Peer Review Committees to spread available funding out among numerous projects has introduced an effective maximum limit.

3. Funding By Type of Proponent

As a result of the emphasis placed upon industry-based research, a much higher proportion of the STDF and STDF-AGAR grant funding has been awarded to private companies than was the case under AGAR. As indicated in Table 2.2, the proportion of funding allocated to private sector companies has increased from about 47% under AGAR to 65% under the amalgamated program. Conversely, the proportion allocated to universities and colleges has declined from about 46% to 33%.

4. Funding By Sector

Funding under AGAR, STDF, and STDF-AGAR has been distributed to a wide variety of economic sectors. As indicated in Table 2.2, the Forestry and Forest Products, and Electronics and Communications have been the leading sectors, receiving about 40% of the grant funding. In reviewing funding by sector, the reader should keep in mind that the committee structure has changed over time and that not all committees have been in existence in each of the 11 years since the AGAR program was introduced in 1979.

5. New Versus Renewal Projects

Approximately 69% of the value of grants awarded under the three programs have been approved for new projects and 31% have been awarded for project renewals. Reflecting the funding guidelines established for STDF-AGAR, the proportion of funding awarded for renewal projects has declined from 40% under AGAR to 26% under STDF-AGAR. STDF was a one year program and, therefore, funding was only available for new projects.

The approval rate has been much higher for renewal projects than for new projects. According to a representative of the Science Council, only about 5% of applications for renewal projects have been rejected. The rejections would usually occur when the applicant had not met the conditions of the original grant, or has not made satisfactory progress with respect to the technical or commercial objectives of the project. As indicated below, the approval rate for new projects is, therefore, estimated to be about 26% as compared to 95% for renewal applications.

APPROVAL RATES FOR NEW VERSUS RENEWAL APPLICATIONS

	New	Renewal	Total
Number Approved	721	390	1,111
Number of Applications	2,775	410	3,185
Approval Rate	26%	95%	35%

If renewal grants are viewed as part of the original project, then 721 distinct projects have been funded under AGAR, STDF, and STDF-AGAR. The average contribution per project, including both new and renewal grants, would be $89,400. The value of the grant for new projects has averaged approximately $61,600 while the average grant for renewals has totalled $51,100.

E. ADMINISTRATIVE STRUCTURE

The administrative structure of STDF-AGAR has evolved from the model established for AGAR. Administration of the program is based upon competitions which are held twice yearly. The deadlines for submission of applications for these competitions are normally May 1 and November 1, annually. The AGAR program went to a competition structure in 1979 as a result of a back-log of applications and a desire to priorize applications rather than to deal with each on a first-come, first-served basis.

The administrative structure for the STDF-AGAR Program consists of the Science Council, the Peer Review Committees, and the Ministry of Advanced Education, Training and Technology as briefly described below:

1. Science Council

The Science Council is responsible for promoting, administering, and monitoring STDF-AGAR. Administration and monitoring is supervised by the Director of Programs and facilitated through the awards group which consists of an Awards Manager and three Awards Officers, and which also receives secretarial support. This group was expanded two years ago in light of the increased grant funding and the accompanying administrative and monitoring requirements. In addition to STDF-AGAR, the awards group also administers the following programs and scholarships:

- Graduate Research, Engineering and Technology (GREAT);
- Health Development Fund;
- Industrial Post Doctoral Fellowships (IPDF);
- Market Assessment of Research and Technology (MART);
- Science and Technology Awards for Returning Students (STARS);
- Training Employment in Science and Technology (TEST).

2. Peer Review Committees

The Science Council has borrowed the concept of peer group review from NSERC. However, rather than establishing committees along functional lines, Science Council committees have been established along sectoral lines.

There are 12 Peer Review Committees currently in operation, covering the following areas:

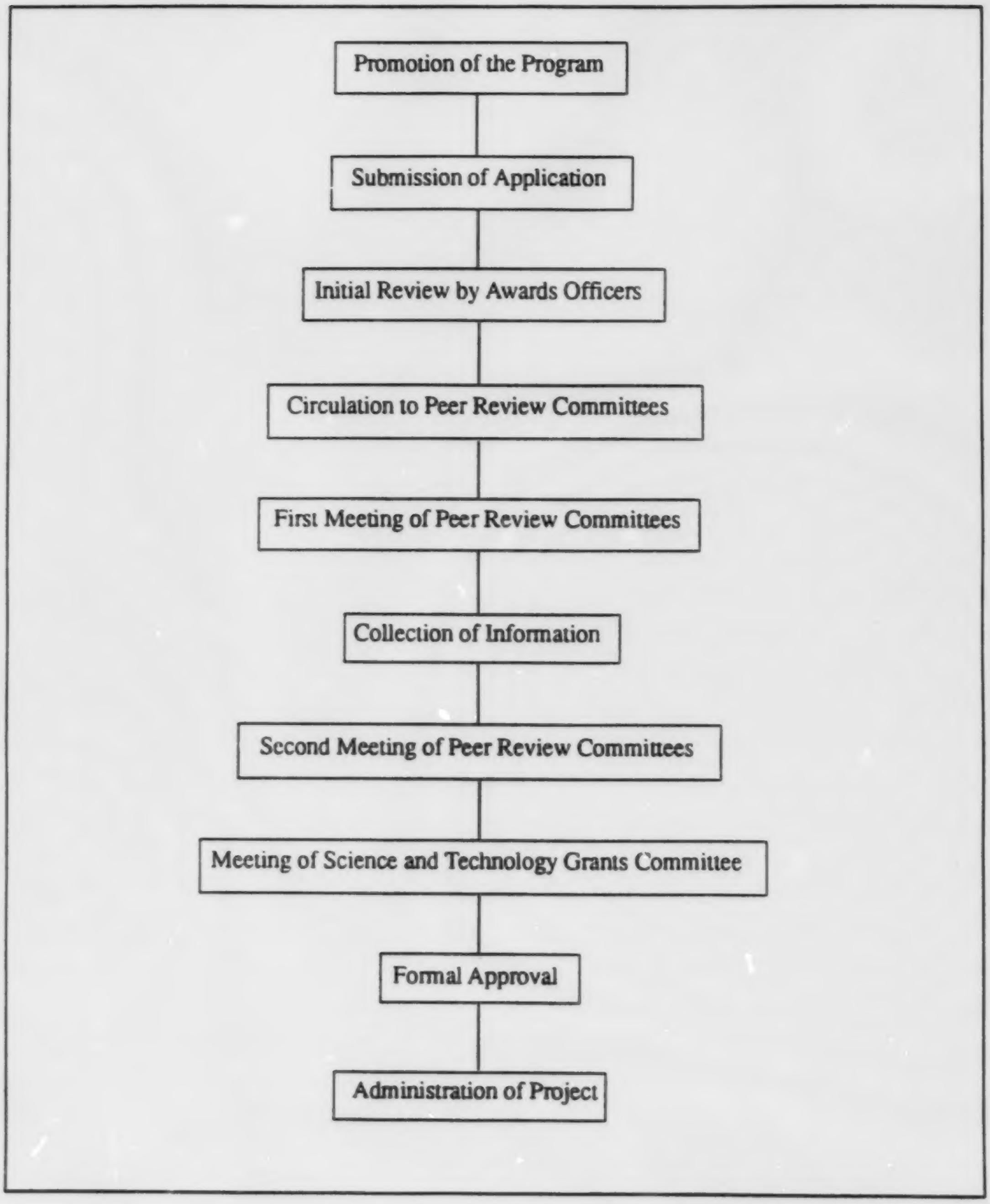
- Agriculture and Food;
- Aquatic Resources;
- Biotechnology;
- Computers and Computing;
- Electronics and Communications;
- Energy;
- Environmental Technology and Waste Management;
- Forestry;
- Forest Products;
- Health Technology;
- Manufacturing and Machinery;
- Mining, Minerals, and Metals.

The number of committees has varied over time depending upon the number of applications received from various sectors. For example, in recent years, the Transportation Committee has been disbanded, the Computers and Computing, Environmental Technology and Waste Management, and the Health Technology Committees have been added, and the Forestry and Forest Products Committee has been divided into two committees.

The committees range in size from 9 members to 15 members. The membership consists of volunteers; the only expenses associated with the committee system relate to the reimbursement of travel expenses. In addition, each committee has a Science Council Liaison Officer. A review of the membership list indicates that, of the 141 members in the 12 committees, 40% were drawn from industry, 32% from educational institutions, 11% from provincial government ministries or federal government departments, 9% from research organizations, and 8% were not specified. The members are appointed for 1 year terms to a maximum of 4 years.

FIGURE 2.1

OVERVIEW OF THE PROJECT REVIEW AND ADMINISTRATION PROCESS


Promotion of the Program
Submission of Application
Initial Review by Awards Officers
Circulation to Peer Review Committees
First Meeting of Peer Review Committees
Collection of Information
Second Meeting of Peer Review Committees
Meeting of Science and Technology Grants Committee
Formal Approval
Administration of Project

The function of the Peer Review Committees is to review and priorize the project applications and develop recommendations regarding which projects should receive funding. The primary advantages of the committee system are that it brings a wide range of expertise to bear on the application process, tends to de-politicize the process in the minds of the applicants, keeps administration costs to a minimum, and increases the flow of information between interest groups.

3. MAETT

The Ministry of Advanced Education, Training and Technology maintains overall control over STDF-AGAR through providing the funding for the program and retaining formal approval over the projects recommended for funding by the Science Council. Where necessary, MAETT is also responsible for preparing Treasury Board Submissions when the amount of an individual grant requires Treasury Board approval.

F. PROJECT REVIEW AND ADMINISTRATION PROCESS

The application and administrative process for the STDF-AGAR program is depicted in Figure 2.1 on the opposite page and briefly described in the following paragraphs:

1. Promotion of the Program

The AGAR program was not heavily promoted, relying primarily upon word-of-mouth and referrals from other agencies as well as encouraging news stories in the media regarding the more successful and interesting projects. Given that the approval rate for applications was already relatively low, it was thought that an awareness program to increase number of applications received was not required. However, introduction of the STDF Competition was supported by a significant promotional program undertaken by the Ministry of Advanced Education and Job Training.

Since the amalgamation of the two programs, STDF-AGAR has continued to be promoted aggressively. In addition to continuing to encourage news stories, promotional vehicles have include newspaper advertisements placed throughout the province before each competition, advertisements in selected trade journals and B.C.-based magazines, promotional news releases and

brochures, public speaking engagements at industry association meetings and conventions, and referrals through SPARK.

2. Submission of Application

The STDF-AGAR program has been reactive, and proponent driven, in that it is the applicant who begins the process by preparing an application for funding. Once an applicant becomes aware of the program, he or she will usually call the Science Council to obtain a preliminary assessment of the applicability of the proposed project and to obtain a copy of the program information and application form.

Depending upon the experience of the applicant in applying to such programs, the length of time required to complete the application may range from 1 day to 1 week. During this period, the applicant will contact an Awards Officer in order to clarify the application process and the nature of the information required. Once completed, the application is submitted directly to the Science Council. Most applications are received in the week prior to the application deadline.

3. Initial Review By Awards Officers

The applications are received and acknowledged by the Science Council. During the one week to two week period following the application deadline, the Awards Manager and Awards Officers review the applications to ensure that they are complete and to determine the Peer Review Committee to which they should be assigned. In some instances, the application may be cross-sectoral and will be assigned to 2 or 3 different committees; one of the committees is designated as the lead committee and will receive input from the other committee or committees. Where the information contained in the application is not complete, the Awards Officers may contact the applicant to fill in the gaps in the application. With the exception of a small number of applications which are clearly outside the program guidelines, no applications are eliminated from consideration at this time.

The Science Council also creates a database containing the list of applicants, applicant addresses, application numbers, topic of research, total cost of the research proposed, amount of assistance requested, program areas into which they fit, and the committee to which they are assigned.

Figure 2.2

EVALUATION CRITERIA

The procedure used to evaluate Technology B.C. applications involves a 4 x 10 matrix scoring system, resulting in sum scores out of 40 and product scores out of 10,000. An application must "score" at least a set minimum score in each of the evaluation categories. Applications are evaluated on the following criteria, attaching equal weight to each of the following categories:

1. **Scientific and Technical Merit** (10 points for this section)
    - Quality of proposed research and development
    - Technical innovativeness
    - Probability of achieving scientific and technical objectives
    - Methodology (problem, approach, solution)
    - Significance to industry
2. **Economic Potential** (10 points for this section)
    - Market potential (domestic and international)
    - Job creation/preservation
    - Sales projections (substantiated)
    - Spin-off benefits (ie. Positive impact on target market)
    - Potential tax generation
    - Payback period
3. **Capabilities and Resources** (10 points for this section)
    - Past performance of applicant
    - Facilities and staff for research and development and commercialization
    - Level of involvement and quality of cooperating organization (where applicable)
4. **Budget and Time Frame** (10 points for this section)
    - % of total costs contributed by applicant and collaborators
    - Cost/benefit ratio
    - Realistic budget
    - Realistic time frame for both completion of project and implementation of results

4. Circulation to Peer Review Committees

Photocopies of the applications are then made and distributed to the members of the Peer Review Committee(s) whose expertise most closely corresponds to the subject area of the application. The members receive a package containing all applications in that area (except those which would violate confidentiality provisions or the conflict of interest guidelines), a statistical analysis of the applications received, guidelines for evaluation, and the tentative timetable for the competition. The members are given 1 week to 2 weeks to review the application prior to a committee meeting.

5. First Meeting of Peer Review Committee

The purpose of the first meeting of the Peer Review Committee is to conduct a preliminary assessment of the applications and to identify what further information will be required to complete the review. Based upon this initial assessment, approximately one-third of the applications are eliminated from consideration. The committee provides a clear reason for rejection which is then presented to the Science Council for communication to the applicant. To assist in priorizing the remaining two-thirds, the committee will recommend a further review process. This process may entail visits to the proposed work site, requesting further information from the applicant, circulating the proposal outside of the committee for an external review, or further assessment by a committee member who will report back to the committee.

6. Second Meeting

After allowing for a period of about 5 to 6 weeks for further review, a second meeting of the Peer Review Committee is held. Prior to the second meeting, supplementary information on the active applications will be forwarded to the committees. At this meeting, the applications are priorized according to a scoring matrix which reflects the criteria established for the program. The evaluation criteria for the program are outlined in Figure 2.2 on the opposite page. As indicated, applications are evaluated on the basis of 4 general categories including:

- Scientific and Technical Merit;
- Economic Potential;
- Capabilities and Resources;
- Budget and Time Frame.

Based upon this system, the committee develops an A-List and B-List of projects. On average, about 40% of the applications received in each area will be placed on either the A-List or the B-List. As indicated earlier, 70% of the funds available for disbursement as research grants in each competition are divided up between the committees in proportion to the total amount of eligible funding requested in each area. The A-list projects are those which the committee recommends be funded with their share of this 70%. The B-list of projects are those which the committee wishes to submit to the Science and Technology Grants Committee for consideration for funding under the remaining 30% of the budget.

7. Meeting of Science and Technology Grants Committee

The Science and Technology Grants Committee consists of the Chairman of each Peer Review Committee, the Council Liaison Member of each committee and representatives of the Science Council. At this meeting, the Grants Committee will review the B-Listed projects and, where the value of the funding requests exceeds the funding available, select the specific projects which will receive funding. It should be noted that, if there are not a sufficient number of high quality projects, not all the funding available may be awarded.

8. Formal Approval

The projects recommended for funding by the committees must first be approved by the President of the Science Council. The list of projects is then submitted to the Minister of Advanced Education, Training and Technology for formal approval. Where the amount of the grant exceeds the provincial Treasury Board guideline (which has ranged from $100,000 to $400,000 in recent years), a Treasury Board Submission must be prepared and approval received prior to notification of the applicant. The applicants are then notified by a letter from the Minister.

9. Administration of Project

Once approved, the applicants are invited to sign a Letter of Agreement which outlines their responsibilities and duties with respect to the grant. In a few instances, the applicant may not accept the funding because of a change in plans or priorities, or because of difficulties in financing the company contribution. Under the conditions of the grant, the proponent must start the project within 3 months and will have 12 months to complete the work.

An advance is provided to cover the first three months. Further payments are conditional upon submission of acceptable quarterly progress reports and financial statements on the work performed. At the end of the year, the proponent must submit an annual report and statement of expenditures. The report will outline the technical results, identify the immediate and potential commercial benefits of the work and outline subsequent work activity. If the report and statement are not received within 60 days of the projected completion date, any committed funds which have not been disbursed will be forfeited and returned to the Science Council for reallocation. The Science Council forwards a bi-annual report to MAETT regarding the progress of the projects.

10. Commercialization

Where the project has proven successful, the proponent has a responsibility, to the extent possible, to promote commercialization of the research results in B.C. According to the conditions of the grant, the *"grant recipient should endeavour to apply the results of the project in B.C. for the benefit of B.C. and should take all reasonable precautions to preclude prior development and exploitation of the result outside B.C., whenever applicable"*. However, in addition to technical considerations, there are a number of factors which can serve to constrain commercial application of the results. Some of these factors include:

- There may not be a market for the product or process developed;
- The proponent may not be able to access the funding required for commercialization;
- Since the commencement of the project, there may have been significant changes in the economy or operating environment which preclude commercialization at this time;
- The project proponent may not have the capabilities required to commercialize the product or process and may not be willing or able to develop the necessary links with those who have the necessary capabilities.

III. PROGRAM RATIONALE

This chapter presents the program model for STDF-AGAR and summarizes our findings with respect to program rationale.

CHAPTER HIGHLIGHTS

The major findings of the evaluation as they relate to the program rationale are summarized as follows:

- According to most representatives surveyed, the need for financial assistance programs such as Technology B.C. which provide funding for applied research and development has increased over the past 3 to 5 years. It is widely recognized that a strong commitment to research and development is required if B.C. is to continue to compete successfully in an increasingly competitive global-based economy.

- The demand and need for funding are likely to remain strong. The infrastructure for applied research and development in B.C. has further developed over the past five years and, consequently, there are now more individuals and organizations competing for funding. The majority of the proponents, responding to our survey, who received funding under AGAR or STDF indicated that they are "likely" or "extremely likely" to apply to the Science Council for applied research and development grant funding over the next few years.

- The role of financial assistance programs in stimulating applied research and development which assists in the development and maintenance of competitive advantages and promotes economic growth and diversification is widely recognized within the Government of British Columbia and the Government of Canada.

- While there are a variety of other Federal and Provincial Government programs which may provide funding for applied research and development, the level of duplication or overlap has been minimized through a high degree of interaction between the Science Council and Federal Government departments and agencies and Government of B.C. ministries and agencies. For example, the Peer Review

Committees of the Science Council draw representatives from 7 agencies and departments of the Federal Government and 5 ministries of the Provincial Government. In addition, representatives of the Science Council are on the review committees for NSERC and IRAP-M.

A. PROGRAM MODEL

The Program Model for the STDF-AGAR Program is provided in the following paragraphs in terms of program activities, program outputs, and intended impacts and effects.

1. Activities

The primary activities involved in the STDF-AGAR program include:

a. Promotion of the program;
b. Review of applications;
c. Approval and funding of projects;
d. Administration and follow-up.

2. Outputs

The major outputs of the STDF-AGAR Program are as follows:

- Applied research and development activities undertaken by private companies (industry-based research and development);

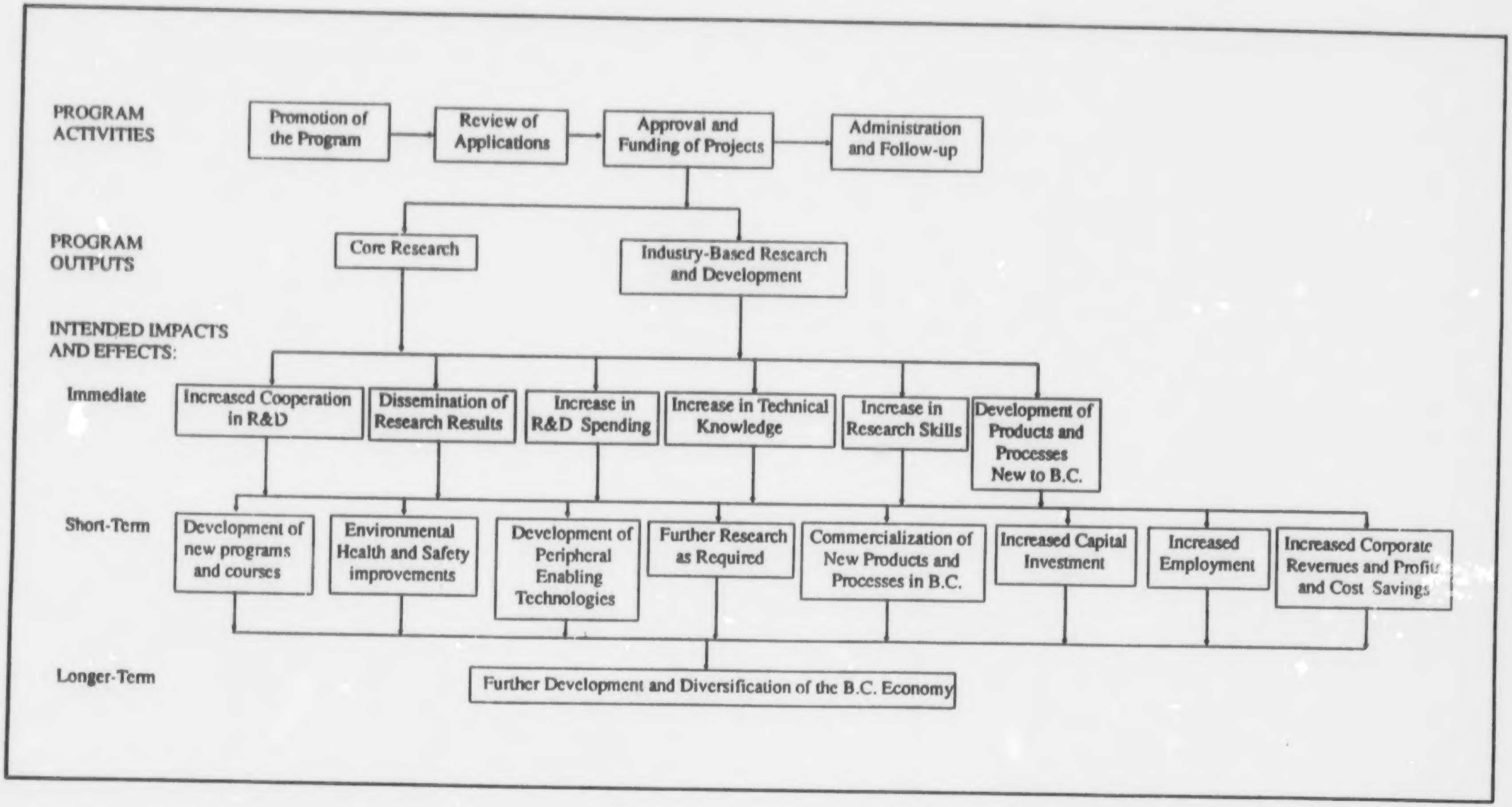
- Applied research and development activities undertaken by post-secondary institutions, not-for-profit agencies or research consortia involving a group of unrelated companies (core research).

3. Impacts and Effects

The intended impacts and effects of the STDF-AGAR Program can be divided into those which would be realized in the immediate term, short-term, and longer-term. In the immediate term, it is

FIGURE 3.1

LOGIC MODEL FOR THE STDF-AGAR PROGRAM


PROGRAM ACTIVITIES
Promotion of the Program
Review of Applications
Approval and Funding of Projects
Administration and Follow-up
PROGRAM OUTPUTS
Core Research
Industry-Based Research and Development
INTENDED IMPACTS AND EFFECTS:
Immediate
Increased Cooperation in R&D
Dissemination of Research Results
Increase in R&D Spending
Increase in Technical Knowledge
Increase in Research Skills
Development of Products and Processes New to B.C.
Short-Term
Development of new programs and courses
Environmental Health and Safety improvements
Development of Peripheral Enabling Technologies
Further Research as Required
Commercialization of New Products and Processes in B.C.
Increased Capital Investment
Increased Employment
Increased Corporate Revenues and Profit and Cost Savings
Longer-Term
Further Development and Diversification of the B.C. Economy

intended that the core research and the industry-based research and development activities will stimulate:

- Increased spending on research and development;
- Increased technical knowledge with respect to products and process;
- Enhanced research skills;
- The development of products and processes new to B.C.;
- Increased cooperation between industry and research agencies such as post-secondary institutions and non-profit organizations;
- Dissemination of research results.

The intended impacts of STDF-AGAR, in the short-term following completion of the funded projects, include:

- Further research, as required for commercialization of the product or process;
- Development of peripheral enabling technologies;
- Commercialization of new products and processes in B.C.;
- Environmental, health and safety improvements;
- Increase in capital investment;
- Increase in employment;
- Increase in corporate revenue and profits and realization of cost savings;
- Development of new educational programs and courses;

Over the longer-term, it is intended that STDF-AGAR will lead to further development and diversification of the B.C. economy.

4. Logic Model

A logic model illustrating the interrelationships between the activities, outputs, and intended impacts of the STDF-AGAR program is provided in Figure 3.1 on the opposite page. As indicated, one of the major causal relationships is that the funding of industry-based research and development projects will lead to the development of products and processes new to British Columbia. The commercialization of these new products and processes will lead to increased employment and corporate income and, over the long-term, will promote further development and

Table 3.1

PERCEIVED CHANGE IN THE NEED FOR SCIENCE COUNCIL PROGRAMS SUCH AS TECHNOLOGY B.C.

Question: In your opinion, has the need for Science Council programs such as Technology B.C., which provides funding for applied research and development, changed over the past 3 to 5 years?

	Type of Respondent				
Response	Project Proponents	Peer Review Committee Member	Program Representatives	Proponent of Rejected or Withdrawn Application	Non-Applicant
No, the need has not changed	19.2%	25.3%	0.0%	38.0%	42.1%
Yes, the need has increased	60.7	63.2	80.0	56.0	47.4
Yes, the need has decreased	0.9	2.3	0.0	0.0	0.0
No opinion or don't know	19.2	9.2	20.0	6.0	10.5
	100.0%	100.0%	100.0%	100.0%	100.0%
Number of Respondents	219	87	5	50	19

diversification of the B.C. economy.

The major focus of the evaluation is on the immediate and short-term impacts. Only if these impacts are achieved are the longer-term impacts likely to be achieved. In addition, the immediate and short-term impacts are more easily measured and directly attributable to program activities.

B. CONTINUED RELEVANCE OF THE PROGRAM

The first evaluation issue relates to the continued relevance of STDF-AGAR.

Issue 1.1: To what extent are the rationale and intended impacts of the STDF-AGAR program still relevant?

In order to determine the extent to which the rationale and intended impacts of the STDF-AGAR program are still relevant, we conducted a review of relevant program and policy documentation and surveyed program representatives, representatives of the Peer Review Committees, past applicants to the programs, and non-applicants. The major findings of our research as they relate to this evaluation issue are as follows:

1. **According to most representatives surveyed, the need for programs such as Technology B.C. which provide funding for applied research and development has increased over the past 3 to 5 years.**

   Of the 219 project proponents who responded to the general questionnaire, 133 or 61% felt that the need for programs such as Technology B.C. has increased in recent years as indicated in Table 3.1. Only 2 of the proponents (0.9%) felt that the need for funding had decreased. The proportion of proponents responding to the questionnaire who felt that the need for the program had increased over the past 3 to 5 years did not vary significantly by type of proponent or year in which the proponent first received funding for applied research and development from the Science Council. For example, 62% of the 98 proponents currently associated with a university or college, 63% of the proponents currently associated with not-for-profit organizations, and 59% of the 94 proponents from the private sector felt that the need for this type of program had increased. Of the 122 respondents who first received a grant from the Science Council prior to 1987, 59% felt that the need had increased whereas 63% of the 97 respondents who received their first grant from the Science Council in 1987, 1988, or 1989 felt that the need had increased.

The majority of the 87 Peer Review Committee members, 5 Science Council program representatives and 50 proponents of rejected or withdrawn applicants included in our survey also believed that the need for programs such as Technology B.C. had increased over the past 3 to 5 years.

The major reasons identified by the Peer Review Committee members, representatives of the Science Council, project proponents, proponents of rejected and withdrawn applications, and non-applicants for the increased need for programs such as Technology B.C. are summarized below (the number of respondents who cited each reason is shown in parenthesis):

- In an increasingly competitive global-based economy, a strong commitment to research and development is required if B.C. is to continue to compete successfully (84 respondents).

  In particular, it was noted by many respondents that British Columbia's traditional resource industries are facing increasing competition. The rate of technological change in the resource sectors, as well as in other sectors of the economy, continues to accelerate. Innovation is required to meet the competitive threat by improving productivity, reducing costs of production, and developing new products and processes which will open new markets for B.C. companies.

- The availability of funding from other sources, particularly the Federal Government, has become more restricted in recent years (41 respondents).

  The respondents cited the restructuring of the Unsolicited Proposals program as coordinated by Supply and Services Canada, the expiration of the various Canada-British Columbia Economic Development Subsidiary Agreements, and more limited access to funding from the Natural Sciences and Engineering Research Council (NSERC) as examples of the reduced availability of funding for applied research and development.

- The infrastructure for applied research and development in B.C. has further developed and, consequently, there are more individuals and organizations competing for funding than there were five years ago (28 respondents).

- The downturn in the economy has constrained the willingness and ability of B.C. based companies to invest in research and development without government support (19 respondents).

  The level of investment in research and development in Canada is normally low in comparison to many other industrialized countries. For example, according to the Ministry of Advanced Education, Training and Technology publication, *"The British Columbia Science and Technology Fund: A Framework for Action"*, Canada spends about 1.3% of its Gross Domestic product on research and development as compared to about 2.5% spent by most successful industrial nations. During a economic downturn, such as that experienced over the past two years, many organizations become even less willing or able to invest in research and development; therefore, some respondents argued that it is during an economic slow-down that programs such as Technology B.C. are most needed to stimulate research and development.

- Increasing awareness of environmental issues has generated greater demand for technologies capable of protecting and improving the natural environment (12 respondents).

2. **The role of financial assistance programs in stimulating applied research and development which assists in developing and maintaining competitive advantages and promotes economic growth and diversification is widely recognized within the Government of British Columbia and the Government of Canada.**

In 1989, The Council of Science and Technology Ministers, which consists of federal and provincial scientific authorities, recognized that a range of strategies is required to effect a significant increase in the level of research and development activities in Canada funding. Included in this range of strategies are programs which provide financial assistance for scientific and technological research and development. The importance of such programs are also highlighted in the *"Long Range Plan, 1990-95"* of the National Research Council, the Government of Canada's principal research and engineering organization.

In 1990, the Government of British Columbia established the *"British Columbia Science and Technology Fund"* with the objectives of assisting in diversifying the economy, enhancing industrial competitiveness in new technologies and traditional industries, helping create export industries, and emphasizing technologies that promote a clean environment and quality of life. The role recognized for government was to provide leadership, coordination and funding. Under the Science and Technology Fund Act, approximately 27% to 35% of the $420 million five year budget for science and technology activities was allocated for the funding of research and development activities.

3. **The flexible nature of the administrative structure established by the Science Council programs has enabled the program to remain relevant by responding relatively quickly to emerging opportunities and issues.**

As an example, the Peer Review Committee structure has varied over time depending upon the number of applications received from various sectors. For example, in recent years, the Transportation Committee has been disbanded, the Computers and Computing, Environmental Technology and Waste Management, and the Health Technology Committees have been added, and the Forestry and Forest Products Committee has been divided into two committees.

However, it should be noted the Technology B.C. program is considerably less flexible with respect to funding options than was the AGAR program. For example, under AGAR there was no formal differentiation between industry-based and core research programs. Furthermore, there was no limit with respect to the proportion of funding granted to new versus renewal projects. A discussion of comments and recommendations regarding program structure received during the evaluation is provided in Chapter V.

4. The majority of the proponents of AGAR and STDF funded projects, who participated in our survey, are likely to apply to the Science Council for applied research and development grant funding over the next few years.

An indicator of the continued relevance of a financial assistance program is the level of demand for funding. As measured by the number of applications received, the demand for Science Council funding for applied research and development has increased in recent years. For example, the number of applications received by the Science Council has increased from an average of less than 100 per competition in the years prior to 1988 to an average of more than 150 in 1990.

In order to obtain an indication of the potential future demand for the kind of programming exemplified by the STDF and AGAR programs, we conducted a survey of past applicants (including proponents of approved, rejected and withdrawn applications) to identify the likelihood that they would apply to the Science Council for funding in the future. As indicated in Table 3.2, the majority of project proponents (58.5%) indicated that they were either "likely" or "extremely likely" to apply to the Science Council for applied research and development grant funding over the next few years. Of the 27 respondents who indicated that they were "not at all likely" or "not very likely" to apply for funding:

- 8 respondents indicated that they will not be undertaking research projects that would be eligible for funding;
- 10 respondents indicated that they will be undertaking research projects but will not require outside funding;
- 4 respondents indicated that they will be undertaking research projects but expect to receive funding under another program;
- 1 respondent will not be applying because he is very dissatisfied that his initial project was not approved for its second year of funding;
- 4 respondents did not provide a reason why they would not be applying.

Table 3.2

LIKELIHOOD OF APPLYING TO TECHNOLOGY B.C. IN FUTURE

Question: How likely is it that you will be applying to Science Council for applied research and development grant funding over the next few years?

Response	Project Proponents	Proponents of Rejected or Withdrawn Applications	Non Applicants
Not At All Likely	6.4%	4.0%	10.5%
Not Very Likely	5.9	12.0	26.3
Somewhat Likely	21.0	4.0	21.1
Likely	15.1	52.0	36.8
Extremely Likely	43.4	28.0	5.3
No Response or Don't Know	8.2	0.0	0.0
	100.0%	100.0%	100.0%
Number of Respondents	219	50	19

The proportion of project proponents who indicated that they were either "likely" or "extremely likely" to apply to the Science Council for applied research and development grant funding over the next few years was slightly higher amongst proponents associated with not-for-profit organizations (70%) than universities and colleges (59%) or the private sector (54%). Of the 122 respondents who first received a grant from the Science Council prior to 1987, 53% were "likely" or "extremely likely" to apply again while 75% of the 97 respondents who received their first grant from the Science Council in 1987, 1988, or 1989 were "likely" or "extremely likely" to apply again.

In addition, 80% of the proponents of rejected and withdrawn applications and 42.1% of the non-applicants we surveyed also indicated that they were either "likely" or "extremely likely" to apply to the Science Council for applied research and development grant funding over the next two years. The leading reasons given by the 8 proponents of rejected or withdrawn applications for being "not very likely" or "not at all likely" to apply in the future included:

- Based upon their past experiences with the program, 3 respondents felt that the probability of success did not warrant the time required to apply to the Science Council for funding;
- 2 respondents indicated that they would not be undertaking a project which would be eligible for funding;
- 1 respondent expects to receive funding under another program;
- 2 respondents did not provide a reason.

Reasons given by non-applicants who indicated that they were "not at all likely" or "not very likely" to apply for funding included: outside funding will not be required; no eligible projects will be undertaken over the next few years; the representative has a very limited awareness of the Technology B.C. program; the application process and reporting requirements are to cumbersome; and the representative does not believe in government financial assistance programs.

C. RELATIONSHIP TO OTHER PROGRAMS

The second evaluation issue addresses the relationship between STDF-AGAR and other government programs designed to promote applied research and development.

Issue 1.2: In what manner and to what extent does STDF-AGAR complement, duplicate, overlap or work at cross-purposes with other provincial or federal programs available in B.C.?

In order to assess the manner and extent to which the Science Council programs which have provided funding for applied research and development have complemented, duplicated, overlapped or worked at cross-purposes to other provincial or federal programs, we conducted a survey of Science Council representatives and Peer Review Committee members, as well as representatives of other programs in order to obtain a description of the mandate, scope and activities of their programs. In addition, we summarized the results of the project specific questionnaires in order to determine the extent to which other programs have complemented AGAR or STDF funding for projects approved by the Science Council. The major findings of our research as they relate to this evaluation issue are as follows:

1. **There are a variety of other Federal and Provincial Government programs which may provide funding for applied research and development.**

   Some of the most prominent programs which have provided funding for applied research and development include:

   - The Natural Sciences and Engineering Research Council (NSERC) provides approximately $8 million in funding annually in B.C. for research and development through Collaborative Research and Development Grants (CRD) and Industrially Oriented Research Grants. Funding of $100,000 per year is available for up to three years. The NSERC programs are designed to foster increased collaboration between universities and industry. Funding under NSERC tends to be targeted at projects which have a longer lead-time to commercialization than do projects which have received funding under AGAR or STDF.

- The National Research Council provides financial assistance to industry through various components of the Industrial Research Assistance Program (IRAP). Approximately $4 million per year is awarded in British Columbia. IRAP is designed to assist in the transfer of foreign technology and the development of new or improved products or processes. The components of the IRAP are targeted at small and medium sized companies and generally on projects which are smaller in scale than those undertaken with funding from AGAR or STDF.

- Under the Western Diversification Program, the Department of Western Economic Diversification Canada provides interest free financing to assist businesses develop new products and technologies and markets.

- The Technology Assistance Program, which is funded under the Science and Technology Development Fund and administered by B.C. Research, provides assistance to small and medium sized companies conducting researching using the facilities of B.C. Research (TAP1) or the services of other research and development companies in British Columbia (TAP2).

- The Industry Science and Trade Canada (ISTC) Advanced Manufacturing Technology Application Program provides funding for studies to examine the feasibility of advanced manufacturing technologies. ISTC also administers the Defence Industry Productivity Program, the Microelectronics and Systems Development Program, and the Strategic Technologies Program.

- Funding for applied research and development has been provided under various subsidiary agreements of the Canada-British Columbia Economic Regional Development Agreements such as the Forest Industry Regional Development Agreement (FIRDA), the Mineral Development Agreement (MDA), and the Agri-Food Regional Development Subsidiary Agreement (ARDSA).

Table 3.3

SOURCES OF FUNDING FOR APPLIED RESEARCH AND DEVELOPMENT PROJECTS WHICH RECEIVED AGAR OR STDF FUNDING

Source of Funding	Number of Projects Receiving	Funding ($'000)	% of Funding
AGAR or STDF	260	$20,069	32.4%
Proponent or Private Sector Organization	240	31,333	50.6
NSERC	49	3,922	6.3
Department of Supply and Services (Unsolicited Proposals)	2	757	1.2
Ministry of Forests or FIRDA	7	695	1.1
Energy Mines and Resources Canada or MDA	5	628	1.0
Western Diversification	2	283	0.5
NRC-IRAP	7	236	0.4
ISTC	3	184	0.3
Universities	12	253	0.5
Other Federal Departments/ Agencies	12	2,178	3.5
Other Provincial Ministries	5	432	0.7
Other	13	920	1.5
All Projects Responding	260	61,890	100.0%

Source: Survey of Project Proponents

2. **While there is potential for duplication, the level of duplication or overlap has been minimized through a high degree of interaction between the Science Council and Federal Government Departments and Agencies and Government of B.C. Ministries and Agencies.**

For example, the Peer Review Committees draw representatives from 7 agencies and departments of the Federal Government and 5 Ministries of the Provincial Government. In addition, representatives of the Science Council are on the review committees for NSERC and IRAP-M. There is also interaction between the Science Council and other funding organizations in referring organizations to each other's programs.

3. **Funding from the Science Council for applied research and development is often complemented by funding from other programs.**

Of the 300 respondents to the project specific questionnaire, 260 respondents were able to identify the proportion of the total research project costs which were covered by the AGAR or STDF award and the sources of funding for the remaining costs. According to the responses of these proponents, AGAR and STDF were, on average, the source of funding for 32.4% of the project costs as indicated in Table 3.3. The leading source of funding for these projects was the proponents and private sector organizations.

As indicated in Table 3.3, funding from the Science Council for applied research and development was often complemented by funding from other programs. For example, of these 260 projects, 49 projects (19%) also received funding from NSERC, 7 projects received funding from IRAP, and 7 projects received funding from FIRDA or the Ministry of Forests.

It should be noted that the proportion of project funding provided by the Science Council is skewed by five large projects for which AGAR or STDF funding represented only a small proportion of total project costs. Excluding these 5 projects, AGAR and STDF was, on average, the source of funding for 43.0% of the project costs. A more detailed description of the sources and uses of project funds is provided in Chapter IV.

IV. IMPACTS AND EFFECTS

This chapter summarizes our findings with respect to the impacts and effects generated by projects funded under AGAR or STDF.

CHAPTER HIGHLIGHTS

The major findings of the evaluation as they relate to the impacts and effects of projects funded under AGAR or STDF are summarized as follows:

- The 833 grants approved under STDF and AGAR were awarded for 527 distinct projects and to 401 different proponents.
- It is estimated that the AGAR and STDF programs have directly funded $29.0 million in wages and benefits and supported over 15,000 person months in project-related employment. Other leading types of expenditures have included the purchase of equipment and the purchase of materials.
- Over 85% of the STDF and AGAR funding has been awarded to organizations in the Lower Mainland/Southwest Development Region and 14% has been awarded to organizations in the Vancouver Island/Coast Development Region.
- The AGAR and STDF programs were, on average, the source of funding for 32.4% of the total costs of applied research and development projects which received funding from the Science Council. Therefore, approximately $2.09 was invested in the projects from other sources for every dollar contributed through the Science Council program.
- It is estimated that 45% of the amount invested from other sources, or $42 million, was incremental in that it would not have been invested in the research and development projects in the absence of Science Council funding.
- Over 60% of the proponents surveyed indicated that the results of the Science Council funded project stimulated further research and development directly related

to the technology. The incremental investment in additional research undertaken by the proponent organization totalled over $26 million.

- Through in-depth interviews with proponents and by undertaking 10 mini-case studies, we were able to obtain information on the 96 products and processes which have already generated commercial impacts. In addition to these projects, our survey identified a further 33 projects are now in their final stages of development and will likely be commercialized in the next 2 to 3 years.

- On average, approximately 40% to 50% of the economic impacts resulting from the commercialization of these 96 products or processes are attributable to the Science Council funded projects in that the product or process would not have been commercialized if the project had not been undertaken.

- Based upon the survey results, it is estimated that 65% of the attributable revenues and costs savings, 66% of the attributable capital investment, and 74% of the attributable employment created or maintained were incremental in that they would not have occurred without funding from the Science Council. These results are believed to be slightly above average for a program of this nature.

- The commercial impacts generated to date by these 96 products and processes which are incremental (would not have been realized in the absence of Science Council funding), as expressed in 1991 dollars, include:

    - Cumulative revenues and cost savings of $83 million. If we assume that the survey has quantified 80% of the actual benefits to date, the incremental revenues and costs savings would be equal to $1.70 per dollar contributed under AGAR or STDF. In addition, a further $116 million in incremental revenues and cost savings is projected to be generated by these 96 products and processes between 1992 and the year 2000;

    - Incremental capital investments, subsequent to the project, totalling about $9.2 million (equal to $0.19 per dollar contributed under

AGAR or STDF, assuming that the survey has quantified 80% of the actual benefits to date);

  - The creation or maintenance of about 227 employment positions involving 830 person-years of employment. If we assume that the survey has quantified 80% of the actual employment benefits to date, approximately 1.71 person years of employment have been created for every $100,000 in funding contributed under AGAR and STDF.

- Projects sponsored by industry (private sector) proponents have provided the greatest return to date per dollar of Science Council funding provided. For example, if we assume that the survey has quantified 80% of the actual benefits to date, industry projects have generated average incremental revenues and costs savings to date of $2.64 per dollar contributed under AGAR or STDF as compared to an average of $0.89 for projects sponsored by proponents associated with universities and colleges.

- Projects recommended by the Electronics and Communication committee and the Manufacturing and Machinery committee have tended to generate the greatest return to date per dollar of Science Council funding provided. However, these results should be taken with relative caution since several committees were only created in 1985 and projects in these sectors have had comparatively less time to generate economic impacts. Furthermore, a number of projects in various sectors have generated intangible benefits which, while difficult to quantify, probably far exceed their tangible economic impacts.

- At least 57 of the 96 commercialized products and processes have also had an economic impact on other B.C. based organizations. For at least five projects, which were the focus of case studies, the magnitude of these impacts was very substantial.

- The Science Council projects have also had significant indirect impacts on the proponent organizations in terms of enhancing their technical knowledge and research capabilities, forging greater research linkages with other organizations, and increasing their willingness to invest in research and development. In addition, Science Council funded projects have contributed to a greater awareness of the Science Council, raised the profile of research and development in B.C., and benefited the general public through environmental, health and safety improvements.

- The need for further research was identified as the major constraint to commercialization for projects not as yet commercialized. Other leading reasons which were identified included the funding necessary for commercialization was not available, the organization did not have the technical or business capabilities required to directly implement the results, and a market sufficient to warrant commercialization was not identified.

A. PROFILE OF PROJECTS AND PROPONENTS

A profile of the projects and proponents has been developed under the following evaluation issue.

Issue 2.1: What are the characteristics of the projects and proponents which have applied for and received funding under AGAR and STDF?

A general description of the projects funded under AGAR, STDF, and STDF-AGAR in terms of new versus renewal projects, type of proponent (private sector businesses, universities and colleges, and not-for-profit organizations), and economic sector was presented in Chapter 2. This information was obtained from the Science Council database. In order to develop a more detailed profile of the projects and proponents, we conducted a review of files for projects approved under STDF and AGAR as well as files on applications which were rejected or withdrawn under STDF-AGAR. In addition, some information regarding the projects and proponents was obtained through a mail survey distributed to the proponents of all projects funded under STDF or AGAR. The findings of the evaluation with respect to this evaluation issue are summarized below:

1. The 833 grants approved under STDF and AGAR were awarded for 527 distinct projects and to 401 different proponents.

A file review was conducted to determine the number of different proponents who received grants (new and renewal) from AGAR or STDF. In the case of a business or a non-profit organization, a proponent is defined as the business or organization. For universities and

TABLE 4.1

NUMBER OF PROJECTS PER PROPONENT
WHO RECEIVED FUNDING FROM AGAR OR STDF

Number Per Person	New Projects		New and Renewal Projects	
	Proponents	%	Proponents	%
1	323	80.5%	205	51.1%
2	46	11.5	95	23.7
3	21	5.2	41	10.3
4	10	2.5	24	6.0
5	0	0.0	17	4.2
6	0	0.0	11	2.7
7	0	0.0	4	1.0
8	0	0.0	3	0.7
9	1	0.3	0	0.0
16	0	0.0	1	0.3
Total Number of Proponents	401	100.0%	401	100.0%
Average Number of Projects/Proponent	1.3		2.1	

colleges, a proponent has been defined as a specific individual (for example, each professor receiving a grant would be considered a distinct proponent). As indicated in Table 4.1, 401 different proponents received grants of which 51% (205 proponents) received only one, 24% received two, and 25% received three or more. The proponents, on average, received 2.1 grants (new and renewal) from STDF and AGAR.

Of the 833 grants awarded under AGAR and STDF, 527 were awarded for new projects. Therefore, proponents received, on average, 1.3 grants from STDF and AGAR for new projects. As indicated in Table 4.1, 81% of proponents were awarded funding for only one new project, 11% were awarded funding for two new projects, and 8% were awarded funding for three or more. One company received funding for 9 new projects and received 16 grants (new and renewal) in total.

Table 4.2 provides a breakdown by type of proponent: universities and colleges; private sector businesses; and not-for-profit organizations. As indicated, 45% of the proponents were associated with universities and colleges while 47% of proponents were drawn from the private sector. Of the 181 proponents associated with universities and colleges, 135 (75%) were associated with the University of British Columbia.

A significantly higher proportion of proponents associated with universities and colleges were awarded funding for two or more new projects (27%) than were private sector businesses (16%) or not-for-profit organizations (6%). As indicated in Table 4.2, 48% of the grants for new projects were awarded to proponents associated with universities and colleges while 45% were awarded to businesses. Overall, representatives associated with the University of British Columbia received 36% of the grants awarded for new projects.

2. **Based upon the survey results, it is estimated that the AGAR and STDF programs were, on average, the source of funding for 32.4% of the total costs of applied research and development projects which received funding from the Science Council.**

Of the 300 respondents to the project specific questionnaire, 260 respondents were able to identify the proportion of the total research project costs which were covered by the AGAR or STDF award and the sources of funding for the remaining costs. According to the responses of these proponents, AGAR and STDF were, on average, the source of funding for 32.4% of the project costs as discussed in Chapter III. Therefore, approximately $2.09

TABLE 4.2

NUMBER OF PROJECTS BY TYPE OF PROPONENT

Type of Proponent	Number of Proponents	%	Number of New Projects One	Number of New Projects Two or More	Total Number of New Projects	%
Universities and Colleges:						
• U.B.C.	135	33.7%	103	32	188	35.7%
• Simon Fraser	33	8.2	23	10	49	9.3
• University of Victoria	12	3.0	9	3	16	3.0
• B.C.I.T.	1	0.2	1	0	1	0.2
	181	45.1%	136	48	254	48.2%
Private Sector Businesses	189	47.1	158	31	238	45.1
Not-for-Profit Organizations	31	7.8	29	2	35	6.7
	401	100.0%	323	78	527	100.0%

was invested in the projects from other sources for every dollar contributed through the Science Council program. Of this $2.09 per dollar contributed, $1.56 was contributed from the proponent or a private sector organization, $0.47 was contributed by other government programs and $0.06 was obtained from other sources.

It should be noted that the proportion of project funding provided by the Science Council is skewed by five large projects for which AGAR or STDF funding represented only a small proportion of total project costs. Excluding these 5 projects, AGAR and STDF was, on average, the source of funding for 43.0% of the project costs (approximately $1.33 was invested in the project from other sources for every dollar contributed through the Science Council program).

The proportion of total project costs funded under Science Council programs varied by type of proponent from approximately 28% for proponents from the private sector and not-for-profit organizations to 40.9% for proponents from universities and colleges as indicated below:

**RELIANCE UPON FUNDING FROM STDF AND AGAR
BY TYPE OF PROPONENT**

Type of Proponent	Proportion of Funding Obtained From AGAR or STDF
Universities and Colleges	40.9%
Not-for-profit Organizations	27.5
Private Sector	27.9
Average for All Types of Proponents	32.4%

Source: Responses of 260 Project Proponents

The figures listed above represent a weighted average. Table 4.3 shows the distribution of projects in terms of the reliance upon the Science Council as a source of funding by type of proponent. As indicated, almost one-third (31.5%) of the projects sponsored by proponents from universities and colleges received over 90% of their funding from AGAR or STDF as compared to only 6.3% of projects sponsored by private sector proponents. In

TABLE 4.3

PROPORTION OF TOTAL PROJECT COSTS FUNDED BY AGAR OR STDF BY TYPE OF PROPONENT

Proportion of Costs Funded By AGAR or STDF	Universities and Colleges	Not-For-Profit Organizations	Private Sector	Total
0 - 10%	2.5%	6.7%	3.5%	3.5%
11 - 20%	4.2	13.3	8.8	7.3
21 - 30%	7.6	3.3	9.9	8.1
31 - 40%	2.5	6.7	24.6	12.7
41 - 50%	21.2	23.4	33.1	26.5
51 - 60%	5.9	10.0	2.6	5.0
61 - 70%	6.8	3.3	1.6	4.2
71 - 80%	10.2	3.3	6.1	7.7
81 - 90%	7.6	0.0	3.5	4.6
91 - 100%	31.5	30.0	6.3	20.4
	100.0%	100.0%	100.0%	100.0%
Number of Respondents	118	30	112	260

Source: Survey of Project Proponents

total, only 20.1% of the projects sponsored by private sector proponents received more than one-half of their funding from AGAR or STDF.

Reliance upon AGAR or STDF as a source of funding has also varied by sector, ranging from a low of 8.8% for projects approved by the Health Technology committee to 66.0% for projects approved by the Agriculture and Food committee as indicated below:

RELIANCE UPON FUNDING FROM STDF AND AGAR BY SECTOR

Sector Committee	Proportion of Funding Obtained From AGAR or STDF
Agriculture and Food	66.0%
Aquatic Resources	60.6
Biotechnology	65.5
Computers and Computing	36.1
Electronics and Communication	23.4
Energy	33.5
Forestry and Forest Products	46.3
Health Technology	8.8
Manufacturing and Machinery	27.3
Mining, Minerals and Metals	23.2

3. **Salaries comprised an estimated 64% of the reported expenditures of projects funded STDF and AGAR.**

Proponents are required to report quarterly on their project expenditures. To prepare a profile of these expenditures, a detailed file review was conducted of 467 projects funded under STDF and AGAR including competitions RC-10 (May 1984) to RC-20 (May, 1989). As indicated in Table 4.4, almost two-thirds (64.1%) of reported expenditures related to wages and salaries, 14.7% related to the purchase of equipment, and 10.3% related to the purchase of materials. Other leading types of expenditures including overhead, travel, and computer costs. If we assume that 64% of the Science Council funding has been applied to wages and salaries, then the AGAR and STDF programs directly funded $29.0 million in wages and benefits based upon the total approved funding of $45.2 million.

Table 4.4

SUMMARY OF STDF AND AGAR REPORTED PROJECT EXPENDITURES

Competition	Files Reviewed	Percentage of Expenditures by Category								Total Expendi tures ($000)
		Salaries	Equipment	Travel	Computing	Materials	Overhead	Other	Total	
RC-20	42	72.3%	11.2%	1.9%	0.3%	12.7%	0.0%	1.6%	100.0%	$2,258.3
STDF 88	77	47.6	29.2	2.4	1.9	8.0	5.2	5.7	100.0	7,513.2
RC-19	47	62.8	6.2	2.0	1.3	25.8	0.0	1.9	100.0	2,452.7
RC-18	38	78.0	4.5	1.6	0.3	10.4	1.3	3.9	100.0	1,706.9
RC-17	47	72.0	9.2	2.7	1.6	8.1	0.2	6.3	100.0	2,231.4
RC-16	29	72.6	9.5	4.2	3.4	5.0	0.7	4.7	100.0	1,576.7
RC-15	35	72.2	7.8	1.7	0.6	9.5	5.8	2.4	100.0	1,757.8
RC-14	33	66.5	9.1	3.4	0.0	12.6	1.2	7.2	100.0	1,573.2
RC-13	44	74.7	8.6	2.4	0.6	7.6	2.4	3.8	100.0	1,697.0
RC-12	24	62.4	18.8	2.6	3.1	8.0	2.6	2.5	100.0	1,228.5
RC-11	32	70.4	7.0	4.0	2.7	8.2	2.6	5.1	100.0	1,774.4
RC-10	29	7.13	13.1	3.2	1.3	6.9	2.4	1.8	100.0	1,166.2
Total	467	64.1%	14.7%	2.6%	1.5%	10.3%	2.6%	4.3%	100.0%	$26,936.5
Expenditures ($000)		$17,265	$3,911	$689	$397	$2,776	$697	$1,151	$26,937	

The STDF projects tended to involve proportionately greater expenditures on equipment (29%) and proportionately lower expenditures on salaries (48%) than AGAR projects. Excluding STDF projects, 70.5% of reported expenditures of AGAR projects related to wages and salaries while 9.1% related to the purchase of equipment.

It should be noted that these figures are based upon reported expenditures, which are not necessarily equal to total project expenditures. The proponent may have incurred research and development costs prior to, during, or after completion of the AGAR or STDF project which were not reported to the Science Council. For the contests RC-10 to RC-20, the funding provided by AGAR or STDF averaged 88.4% of reported expenditures. Given that AGAR and STDF funding average 32.4% of total project costs, according to the proponents responding to our survey, this suggests that less than 40% of the total project costs are reported to the Science Council.

4. **It is estimated that, on average, over 2 years of employment per project were paid for out of total project costs.**

The 300 respondents to our mail survey were asked to estimate the number of person months of employment that were paid for out of the total cost of their projects. As indicated in Table 4.5, 226 of the 300 respondents surveyed (75.3%) were able to provide an estimate. A total of 6,487 person months of employment were paid out of the total cost of these 226 projects, equal to an average of 28.7 person months per project. Assuming that the average employment created by all projects which received funding under AGAR or STDF was 28.7 person months, the AGAR and STDF programs supported over 15,000 person months in project-related employment.

University and college sponsored projects accounted for about 49% of the reported number of person months while industry-based projects accounted for about 46%. In terms of sector, employment was primarily generated by projects in the areas of energy (22.7% of total), forestry (17.1%), electronics and communications (13.0%), aquatic resources (12.3%) and manufacturing and machinery (9.9%). The average number of person months of employment per project ranged from a minimum of 17.6 months in the computers and computing sector to a maximum of 44.6 months in the energy sector.

Table 4.5

PERSON MONTHS OF EMPLOYMENT PAID OUT OF TOTAL PROJECT COSTS

Question: Approximately how many person months of employment were paid out of the total costs of this project ?

	Number of of Projects	%	Number of Person-Months	%	Average Person-Months per Project
By Type:					
Industry	97	42.9%	2,968	45.8%	30.6
University	104	46.0%	3,162	48.7%	30.4
Non-Profit	25	11.1%	357	5.5%	14.3
Total	226	100.0%	6,487	100.0%	28.7
By Sector:					
Agriculture & Food	23	10.2%	542	8.3%	23.6
Aquatic Resources	25	11.1%	797	12.3%	31.9
Biotechnology	6	2.6%	241	3.7%	40.2
Computers & Computing	17	7.5%	298	4.6%	17.6
Electronics & Communications	30	13.3%	845	13.0%	28.2
Energy	33	14.6%	1,473	22.7%	44.6
Forestry & Forest Products	52	23.0%	1,110	17.1%	21.3
Health Technology	4	1.8%	78	1.2%	19.5
Manufacturing & Machinery	21	9.3%	643	9.9%	30.6
Mining, Minerals & Metals	15	6.6%	460	7.2%	30.7
Total	226	100.0%	6,487	100.0%	28.7

Source: Mail survey of 300 project proponents
Note: 86 of the 300 respondents did not provide an estimate

5. **The STDF and AGAR projects have been heavily concentrated in the Lower Mainland/Southwest and, to a lesser extent, the Vancouver Island/Coast Development Regions.**

A review of the projects funded under AGAR and STDF was conducted to estimate the distribution throughout the various regions of the province. As indicated in Table 4.6, based upon the address of the proponent, it is estimated that over 85% of the STDF and AGAR project expenditures have been occurred in the Lower Mainland/Southwest Development Region and 14% has occurred in the Vancouver Island/Coast Development Region. While limited amounts of funding has been awarded for proponents based in the Thompson-Okanagan and Cariboo, no funding has been approved for proponents based in the Kootenay, North Coast, Nechako or North East Development Regions.

To determine whether the regional distribution of funding under STDF-AGAR has varied significantly from the pattern of distribution existing under AGAR or STDF 88, we also conducted a review of the funding awarded under the STDF-AGAR competitions SA-1, SA-2, and SA-3. As indicated below, the regional distribution of funding under STDF-AGAR has been consistent with past programs as approximately 83% of the funding has been awarded to proponents based in the Lower Mainland/Southwest Development Region and 15% has been awarded to proponents based in the Vancouver Island/Coast Development Region.

REGIONAL DISTRIBUTION OF FUNDING UNDER STDF-AGAR

Development Region	Proportion of Funding Awarded
Lower Mainland/Southwest	83.0%
Vancouver Island/Coast	15.1
Okanagan	1.6
Cariboo	0.2
Kootenay	0.1
Other Development Regions	0.0
Total	100.0%

Source: File review

Table 4.6

AGAR AND STDF EXPENDITURES BY DEVELOPMENT REGION

Competition	Vancouver Island/ Coast	Lower Mainland/ Southwest	Thompson Okanagan	Kootenay	Cariboo	North Coast	Nechako	North East	Total	Expenditures ($ million)
RC-20	8.8%	90.7%	0.0	0.0	0.5%	0.0	0.0	0.0	100.0%	$2.3
STDF 88	14.3	81.4	1.9	0.0	2.4	0.0	0.0	0.0	100.0	7.5
RC-19	7.4	92.1	0.5	0.0	0.0	0.0	0.0	0.0	100.0	2.4
RC-18	11.1	88.1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.7
RC-17	21.9	78.1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	2.2
RC-16	19.3	80.7	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.6
RC-15	9.8	90.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.8
RC-14	12.3	87.7	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.6
RC-13	17.1	82.9	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.7
RC-12	17.1	82.9	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.2
RC-11	14.2	85.8	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.8
RC-10	9.1	90.9	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1.1
Total	13.6%	85.2%	0.6%	0.0	0.6%	0.0	0.0	0.0	100.0%	$26.9

Source: Review of Project Files

6. **The private sector proponents varied from small companies with fewer than 4 employees and annual sales of less than $100,000 to very large companies with sales of close to $1 billion.**

A file review was undertaken to determine the average size of companies which have received funding from STDF 88 or AGAR under competitions RC-10 to RC-20. During these competitions, 235 grants to private sector firms were approved. The characteristics of these firms in terms of annual revenues and number of employees are summarized below:

- Annual revenues per firm averaged $23.8 million.

  Of the 235 proponents, 145 provided a figure on their total annual revenues. The average is skewed upwards by several grants awarded to very large companies. As indicated below, the majority of firms reporting sales indicated annual revenues of less than $1 million per year.

ANNUAL REVENUES PER FIRM

Current Revenues	Firms Reporting	Share
Less than $100,000	34	23.4%
$100,000 to $199,999	18	12.4
$200,000 to $499,000	14	9.7
$500,000 to $999,999	27	18.6
$1,000,000 to $1,999,999	17	11.7
$2,000,000 to $9,999,999	20	13.8
$10,000,000 or greater	15	10.3
Total	145	100.0%

Source: File review

- An average of 481 employees per firm.

  Of the 235 proponents, 200 provided a figure on their total number of employees. The average is again skewed upwards by several grants awarded to very large companies. As indicated below, the majority of firms reported having fewer than 19 employees.

Table 4.7

USE OF COOPERATING ORGANIZATIONS BY TYPE OF PROPONENT

Type of Proponents	Number of Proponents	Sole Projects	%	Number of Cooperating Organizations	Number/ Proponent	Type of Cooperation Organizations: Universities and Colleges	Private Sector Businesses	Not-for-Profit Organizations	Government Agencies	Total
Universities and Colleges	206	8	3.9%	337	1.6	0.3%	74.7%	3.6%	21.4%	100.0%
Private Sector Businesses	180	51	28.3%	216	1.2	25.9%	43.1%	5.1%	25.9%	100.0%
Not-for-Profit Organizations	28	5	17.9%	51	1.8	2.0%	78.4%	2.0%	17.6%	100.0%
	414	64	15.5%	604	1.5	9.6%	64.7%	4.0%	22.7%	100.0%

Source: Review of Project Files

NUMBER OF EMPLOYEES PER FIRM

Number of Employees	Firms Reporting	Share
0 to 4	41	20.5%
5 to 9	41	20.5
10 to 19	40	20.0
20 to 49	28	14.0
50 to 199	30	15.0
200 to 499	10	5.0
500 or greater	10	5.0
Total	200	100.0%

Source: File review

7. **The AGAR and STDF programs were successful in bringing together different organizations as participants in the same project.**

A review was conducted of projects approved under STDF and AGAR under competitions RC-10 to RC-20 in order to identify the proportion of proponents who indicated that other organizations (such as universities and colleges, private companies, not-for-profit organizations, or government agencies) were also participating in the project. Of the 414 projects reviewed, only 64 (15.5%) were sole projects in that there were no other organizations other than the proponent involved in the delivery of the project. In total, the 414 proponents identified 604 cooperating organizations. Of the 604 organizations, 64% were private sector businesses, 23% were government agencies, 4% were not-for-profit organizations and 9% were universities and colleges.

Table 4.7 summarizes the results of this review by type of proponents. As indicated, there are two significant differences in the use of cooperating organizations by type of proponent including:

- Whereas only 3.9% of university and college sponsored projects were sole projects, 28.3% of private sector business sponsored projects involved no cooperating organizations.

Table 4.8

NUMBER OF PROJECTS STIMULATING FURTHER RESEARCH AND DEVELOPMENT ACTIVITIES

Question 1:	**Have the results of the project stimulated further research and development activity related to this product or process ?**
Question 2:	**If yes, was this research undertaken by your organization or a different organization ?**
Question 3:	**Have the results of the project stimulated further research and development activity not directly related to this product or process ?**

	Number of Respondents	**%**
Question 1		
Yes	195	65.0%
No	59	19.7%
Don't know	22	7.3%
No response	24	8.0%
Total	300	100.0%
Question 2		
Our organization	130	66.7%
A different organization	28	14.4%
Both	36	18.4%
No response	1	0.5%
Total	195	100.0%
Question 3		
Yes	125	41.7%
No	95	31.7%
Don't know	40	13.3%
No response	40	13.3%
Total	300	100.0%

Sources: Mail survey of 300 project proponents.

- University and college based proponents and not-for-profit proponents tended to cooperate primarily with private sector businesses. Private businesses tended to cooperate with other businesses (43% of cooperating organizations), universities and colleges (25.9%), and government agencies (25.9%).

Approximately 60% of the 414 projects reviewed involved both a private sector business and a university or college as a proponent or cooperating organization.

B. IMPACT IN TERMS OF FURTHER RESEARCH AND DEVELOPMENT

The evaluation issue developed with respect to the impact of Science Council funded projects on research and development activities is as follows:

Issue 2.2: In what manner and to what extent have the projects which received funding from AGAR and STDF promoted further research and development?

Information concerning the impact of the Science Council funded projects on research and development was obtained through a mail survey distributed to the proponents of the 527 projects funded under AGAR and STDF. The findings of our evaluation with respect to this evaluation issue are summarized below:

1. **Almost two-thirds (65%) of the proponents indicated that the results of the Science Council funded project stimulated further research and development directly related to the technology.**

   The 300 respondents to the mail questionnaire were surveyed to determine whether the results of their project had, to their knowledge, stimulated further research and development activity related to the technology (separate from the Science Council funded project). As indicated in Table 4.8, 195 of the 300 respondents (65.0%) indicated that their project did indeed stimulate additional research and development activities. In at least 46 instances, the additional research was required because the initial project proved more time-consuming or complex than anticipated. In addition, the initial research for at least 35 projects

revealed broader applications than anticipated and further research was conducted to explore these opportunities.

Of the remaining 105 projects, 59 projects (19.7%) definitely did not lead to further research and development activities. For the other 46 projects, the proponents were either uncertain as to whether further research had been undertaken or did not respond to the question.

The proportion of projects which stimulated further research and development ranged from 37% for projects sponsored by not-for-profit organizations to 68% for projects sponsored by universities and colleges and to 70% for projects sponsored by industry. The proportion of projects which stimulated further research and development did not vary significantly by sector ranging from a low of 53% for projects recommended by the Mining, Minerals and Metals committee to 74% for projects recommended by the Agriculture and Food committee.

2. **For two-thirds (67%) of the projects, this additional research and development was conducted solely by the proponent's organization.**

Proponents of projects stimulating further directly related research and development activities were asked whether this additional research had been undertaken by their own organization or by others. As indicated in Table 4.8, 130 of the 195 respondents (66.7%) indicated that this additional research and development was conducted by their organization only, while 28 respondents (14.4%) indicated that it was undertaken by another organization. In 36 cases (18.4%), the further research and development was conducted by both the proponent's organization and another organization.

In 52 of the 64 instances (81.2%) where the additional research was undertaken by another organization, the proponent of the original project was involved in the research (usually in an advisory capacity). The leading methods for disseminating the results of the Science Council funded project to the other organization included publications (34 respondents), seminars and conferences (19 respondents) and personal contact (19 respondents). Concerning the use of intellectual property by the other organization, patent or licensing agreements were concluded related to 26 of the 64 projects (40.6%). No arrangements were made concerning the results of the remaining 38 projects because:

Table 4.9

PROFILE OF PROJECTS STIMULATING FURTHER DIRECTLY RELATED RESEARCH AND DEVELOPMENT ACTIVITIES

	Number of Projects Stimulating Further Related Research	%	Number of Proponents Undertaking this Research	%	Cost of Additional Research & Development ($000)	%	Average Cost per Project ($000)
By Type:							
Industry	91	46.7%	78	47.6%	$ 20,446	50.9%	$ 262
University	93	47.7%	74	45.1%	13,661	34.0%	185
Non-Profit	11	5.6%	12	7.3%	6,052	15.1%	504
Total	195	100.0%	164	100.0%	40,159	100.0%	245
By Sector:							
Agriculture & Food	20	10.3%	15	9.1%	$ 1,131	2.8%	$ 75
Aquatic Resources	23	11.8%	19	11.6%	1,385	3.4%	73
Biotechnology	5	2.6%	5	3.1%	352	0.9%	70
Computers & Computing	15	7.7%	15	9.1%	2,111	5.3%	141
Electronics & Communications	28	14.3%	25	15.2%	11,835	29.5%	473
Energy	25	12.8%	21	12.8%	4,582	11.4%	218
Forestry & Forest Products	42	21.5%	34	20.7%	11,538	28.7%	339
Health Technology	5	2.6%	5	3.1%	2,970	7.4%	594
Manufacturing & Machinery	22	11.3%	17	10.4%	2,805	7.0%	165
Mining, Minerals & Metals	10	5.1%	8	4.9%	1,450	3.6%	181
Total	195	100.0%	164	100.0%	40,159	100.0%	245

Sources: Mail survey of 300 project proponents.

- The original project results were not patentable or fell in to the public domain;

- The other organization undertaking the additional research was the cooperator involved in the initial Science Council funded project;

- The other organization acquired or merged with the organization conducting the initial research.

3. **The proponent organizations invested over $40 million in additional research and development.**

The 164 respondents who indicated that their organization had undertaken additional research and development were surveyed to determine the cost of this additional research. As indicated in Table 4.9, the cost of this additional research and development to date was estimated to total $40.2 million, equal to $245,000 per Science Council funded project. This estimate of $40 million in additional research and development should be considered very conservative for the following reasons:

- The 300 proponents who responded to our mail survey, and from whom these results were derived, represent only 56.9% of all projects funded under the AGAR and STDF programs;

- Of these 300 respondents, only 254 (84.7%) were able to answer whether the results of their Science Council funded project had stimulated any further related research and development;

- This estimate only captures the cost of the additional research undertaken by the respondents' organizations and does not include the costs of additional research conducted by other organizations.

4. **Over 50% of the additional investment was stimulated by the results of projects in the electronics/communications and forestry sectors.**

Table 4.9 provides a breakdown of the cost of the additional research and development, to date, by type of proponent and by economic sector. As indicated, industry-sponsored projects have stimulated approximately $20.4 million (50.9%) in additional research and development, while university-sponsored projects have stimulated $13.6 million (34.0%) and projects involving non-profit organizations have stimulated $6.0 million (15.1%).

As indicated in Table 4.9, the additional investments in research and development were primarily stimulated by projects in the areas of electronics and communications ($11.8 million or 29.5% of total), forestry ($11.5 million) and energy ($4.6 million). The average cost of additional research and development per project ranged from a minimum of $70,000 in the biotechnology sector to a maximum of $594,000 in the health technology sector. These results should, however, be taken with relative caution insofar as several committees were only created after 1985 and projects in these sectors have had comparatively less time to generate additional investments in research and development.

5. **In addition, approximately 40% of the proponents indicated that the Science Council funded project had also stimulated further research and development not directly related to the technology.**

The 300 respondents to the mail questionnaire were also surveyed to determine whether the results of their project had, to their knowledge, stimulated further research and development activity not directly related to the product or process being developed. As was indicated in Table 4.8, 125 of the 300 respondents (41.7%) indicated that their project did indeed stimulate such research and development activities. In many instances, the results of the Science Council funded project was applicable to other topics of study and further research was undertaken to determine how these results could apply to other products or processes.

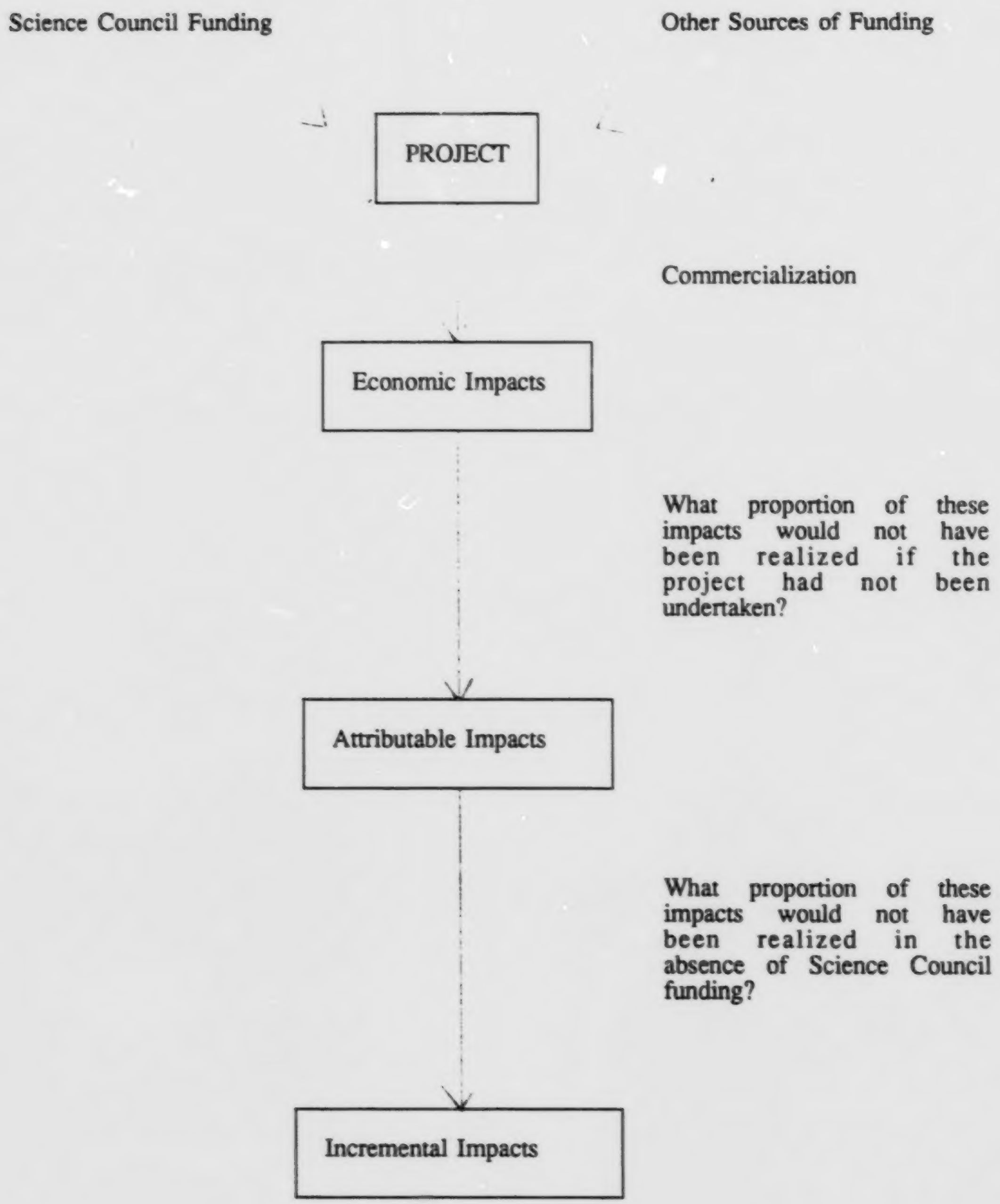
C. IMPACT IN TERMS OF ECONOMIC DEVELOPMENT

The evaluation issue developed with respect to the impact of Science Council funded projects on economic development is as follows:

Issue 2.3: **In what manner and to what extent have the projects which received funding from AGAR and STDF promoted further economic development in British Columbia?**

FIGURE 4.1

CONCEPTS OF INCREMENTALITY AND ATTRIBUTION


Science Council Funding
Other Sources of Funding
PROJECT
Commercialization
Economic Impacts
Attributable Impacts
Incremental Impacts

What proportion of these impacts would not have been realized if the project had not been undertaken?

What proportion of these impacts would not have been realized in the absence of Science Council funding?

Of the 527 projects funded under AGAR and STDF, 108 projects were identified as having led to commercialization. These included:

- 58 projects which were identified through our project specific questionnaire (but which were not identified in the 1987 evaluation);
- 23 projects which were identified through the 1987 evaluation but for which a project specific questionnaire was not returned;
- 27 projects which were identified through our survey and in the 1987 evaluation.

These 108 projects were associated with 99 commercialized products or processes (in some instances, more than 1 project was associated with a single commercialized product or process). Through in-depth interviews with each of the proponents and by undertaking 10 mini-case studies, we were able to determine the commercial impacts of 96 of these products or processes in terms of the resulting revenues, cost savings, net income, capital investment, and employment. In addition, information was obtained concerning the importance of the Science Council funded project in the commercialization process, and the importance of the AGAR or STDF funding in the implementation of the project. Based upon these survey results, three levels of economic benefits were derived:

- **Total economic impacts**

  Total impacts are the economic impacts (revenues, cost savings, net income, capital investment, and employment) resulting from commercialization of the product or process, as reported by the project proponents.

- **Attributable impacts**

  Because Science Council funded projects generally represented one in a series of steps taken in the commercialization of a given product or process, the information they generated may not always have been essential to the commercialization process. Indeed, it is possible that this information could have been collected in some other way or that the Science Council funded project could have been omitted altogether without jeopardizing the commercialization process. Attributable impacts are defined as the proportion of total economic impacts which are directly attributable to the **projects** funded by the Science Council in that they would not have been realized if the projects had not been undertaken.

- **Incremental impacts**

  The funding provided by the Science Council may not always have been essential for these projects to go ahead. Given that Science Council funding represented, on average, 32.4% of the total costs of the funded projects, it is possible that many of the projects could have been undertaken, in part or in full, even in the absence of Science Council funding. Incremental impacts represent the proportion of attributable impacts which can be directly credited to the **funding** provided by the Science Council in that they would not have been realized in the absence of Science Council funding.

This section discusses the major findings of our evaluation with respect to the total economic impacts and the attributable impacts. The extent to which these impacts are incremental is addressed in Section E.

Commercial Success

1. **The majority of projects were moderately successful or successful in accomplishing their commercial objectives.**

The 300 respondents to the mail questionnaire were asked to rate how successful their funded projects were in accomplishing their commercial objectives. Fifty respondents (16.7%) were unable to answer this question because their projects did not have any commercial objectives *per se*. These included projects recommended for special support by MAETT and infrastructure/equipment funding provided under the Core Sub-Program to some university researchers. Of the remaining 250 projects, 80 projects (32.0%%) were deemed "successful" in accomplishing their commercial objectives, and a further 67 projects (26.8%) were "moderately successful" in this regard. Only 20 projects (8.0%) were deemed "extremely successful", while 36 projects (14.4%) were "not at all successful" as indicated below:

ACHIEVEMENT OF COMMERCIAL OBJECTIVES

Question: How successful was the project in accomplishing its commercial objectives ?

	Number of Respondents	Share
Not at all successful	36	12.0%
Not very successful	47	15.6%
Moderately successful	67	22.3%
Successful	80	26.7%
Extremely successful	20	6.7%
No response	50	16.7%
Total	300	100.0%

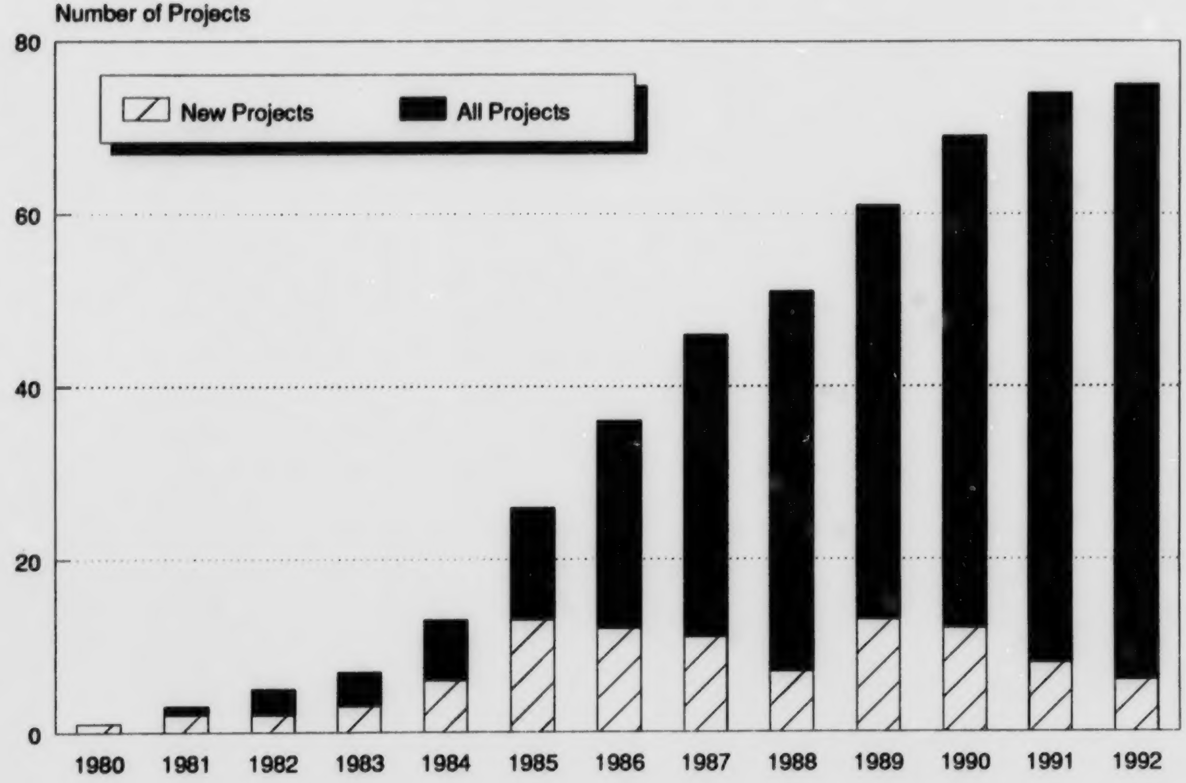
Source: Mail survey of 300 project proponents

Current Commercial Status

2. **In addition to the projects which have already been commercialized, our survey identified a further 33 projects (11.0%) are now in their final stages of development and will likely be commercialized in the next 2 to 3 years.**

As indicated below, 78 of the 96 commercialized projects were identified through a mail survey of 300 project proponents asking them to report on the current commercial status of their project (the remaining 18 projects were identified through the 1987 evaluation).

Figure 4.2
NUMBER OF COMMERCIALLY ACTIVE PROJECTS
1980-1992



	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
All Projects	1	3	5	7	13	26	36	46	51	61	69	74	75
New Projects	1	2	2	3	6	13	12	11	7	13	12	8	6

CURRENT COMMERCIAL STATUS

Question: With respect to the product or process which was the focus of the research project, which of the following best describes the current commercial status of the research and development ?

	Number of Respondents	**Share**
The results have been implemented commercially	78	26.0%
There are plans to commercialize the results in the next 2 to 3 years	33	11.0%
The results are yet to be implemented commercially; however, further research is planned or is on-going which may lead to commercialization	56	18.7%
There are no plans to commercially implement the product or process	60	20.0%
Other	23	7.7%
No response	50	16.6%
Total	300	100.0%

Source: Mail survey of 300 project proponents

Of the 300 projects for which a questionnaire was returned, a further 33 projects (11.0%) are now in their final stages of development and will likely be commercialized in the next 2 to 3 years. An additional 56 projects (18.7%) still require further research which ultimately may or may not lead to their commercialization. The remaining 60 projects (20.0%) have either become inactive and/or there are no plans to implement them commercially.

3. **Seventy-five of the 96 commercialized projects included in our survey are still commercially active.**

Figure 4.2 provides a breakdown of all commercialized projects by year of commercialization, as well as the total number of commercially active projects by year between 1980 and 1992. As indicated, the number of commercially active projects increased from one project in 1980 to 26 projects in 1985, 69 projects in 1990 and 75 projects in 1992. Eighty-two of the 96 commercially implemented projects (85.4%) were commercialized between 1986 and 1992. It should be noted that the number of commercially active projects for any given year does not necessarily add up to the sum of all projects commercialized up to and including that year, as previously commercialized projects may no longer be commercially active.

Attribution

4. **For the majority of the commercialized products and processes, the Science Council funded project was an important and necessary step in the process of commercialization.**

Proponents of the 96 projects which led to commercialization were surveyed to assess the importance of the Science Council funded project in the development of commercial products and processes, and to determine whether these products/processes still would have been commercialized even if the Science Council funded project had not been undertaken. As indicated below, only one product/process (1.0%) would still "definitively" have been commercialized even if the Science Council funded project had not been undertaken, and another 20 products/processes (20.8%) would "likely" have been commercialized.

IMPORTANCE OF PROJECTS IN THE COMMERCIALIZATION PROCESS

Question: We would like to find out how important this project was to commercialization of this product or process. If the project had not been undertaken, how likely is it that the product or process would have still been commercialized ?

	Number of Respondents	Share
No chance at all (0% chance)	4	4.2%
Unlikely (25% chance)	35	36.5%
Even chance (50% chance)	36	37.5%
Likely (75% chance)	20	20.8%
Definitely would (100% chance)	1	1.0%
Total	96	100.0%

Average Response: 44.5%

Source: Survey of 96 proponents of commercialized projects

For the most part, these were products/processes for which the Science Council funded project was part of a much larger research and development program, or for which the information generated by the Science Council funded project could have been collected in some other way or was not essential to the commercialization of the product or process.

In the absence of the Science Council funded project, the likelihood that the remaining 75 products/processes (78.1%) would have been commercialized is 50% or less. In many instances, the Science Council project was essential to the development of a product or process in that it facilitated either the transition from a concept to a working prototype, or from a prototype to a commercially viable product/process.

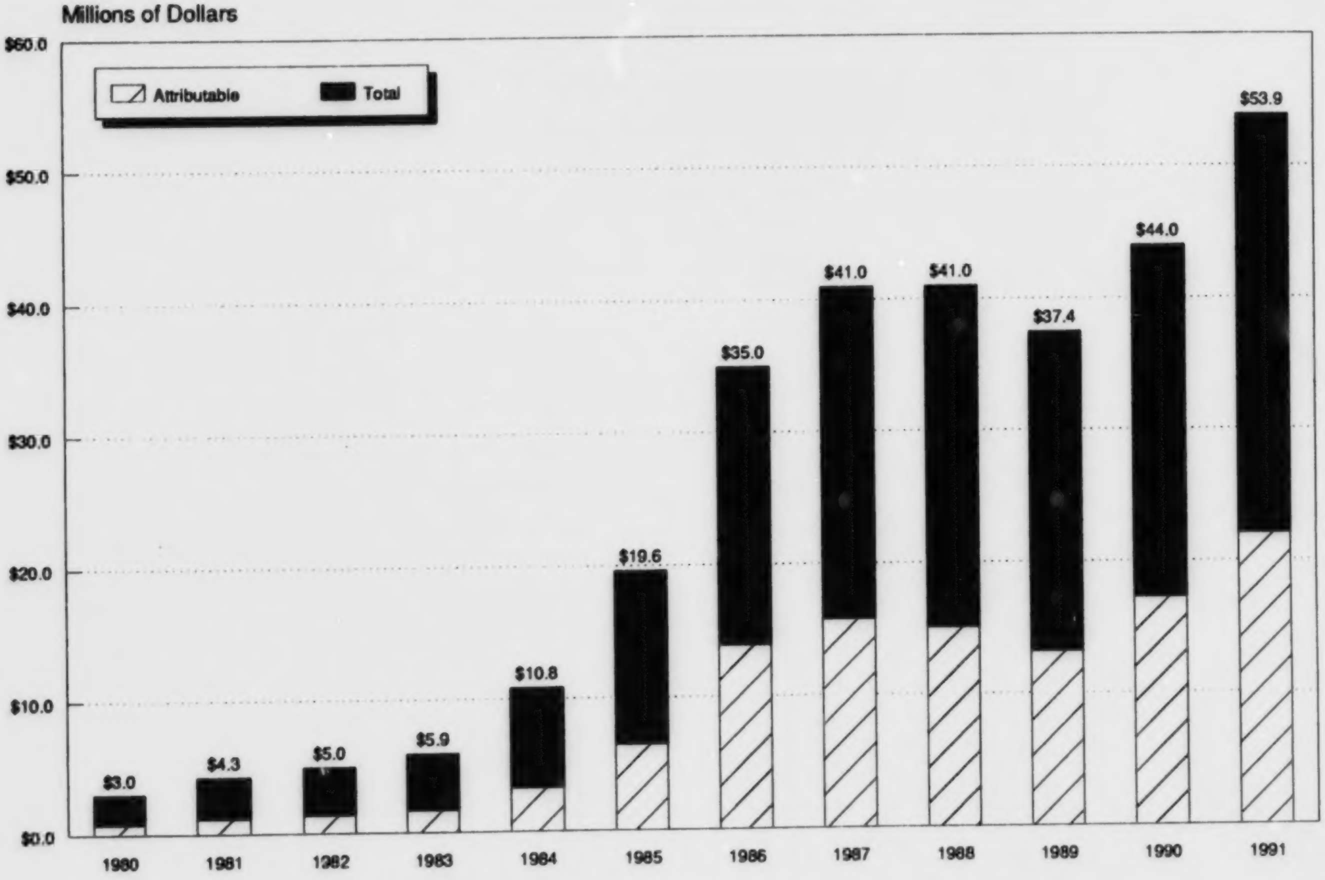
5. **However, the majority of completed projects required at least some additional research and development before they were ready for commercialization.**

Of the 96 commercialized projects, only 30 (31.2%) were, according to their proponents, commercialized almost immediately after completion of the STDF or AGAR funded project. By comparison, 50 projects (52.1%) required additional research and development and/or testing before they could be commercialized, often because of unforeseen technical problems. Research is still on-going for many projects to ensure their continued competitiveness in the market place. In addition, some proponents had to develop the infrastructure required for commercial production, develop a marketing program, apply for patents and obtain approvals from regulatory bodies before their projects could be commercialized.

6. **Projects were, on average, commercialized approximately 3 years after being funded by the Science Council.**

The 96 commercialized projects surveyed during the course of the study were, on average, commercialized about 32 months after first receiving Science Council support as indicated below:

Figure 4.3
IMPACT ON REVENUES/COST SAVINGS
AS REPORTED BY RESPONDENTS, 1980-1991



TIME ELAPSED BETWEEN PROJECT FUNDING AND COMMERCIALIZATION

Time Elapsed	Number of Respondents	Share
Less than 1 year	6	6.2%
1 year	18	18.8%
2 years	28	29.2%
3 years	19	19.8%
4 years	15	15.6%
5 years	4	4.2%
Over 5 years	6	6.2%
Total	96	100.0%

Average: 32 months (2 years and 8 months)

Source: Survey of 96 proponents of commercialized projects

Indeed, 71 projects (74.0%) were commercialized less than 3 years after first receiving Science Council support, despite the fact that about 40 projects (41.7%) were multi-year projects (i.e. received Science Council support for 2 or more years). In other words, it is reasonable to assume that many of these projects were commercialized about 12 months to 18 months after their completion. These results reflect the short-term focus of the program; however, the results may under-estimate the time required for commercialization given that the 33 projects which are now in their final stages of development and will likely be commercialized in the next 2 to 3 years are not included in the average.

Impact on Revenues and Cost Savings

7. **The products and processes which were the focus of the Science Council funded projects generated total revenues and cost savings of about $53.9 million in 1991.**

Detailed interviews were held with the proponents of the 96 projects leading to commercialization in order to collect information on the impact of these projects in terms of the annual revenues and cost savings since commercialization. Of the 96 projects, 91 (94.8%) have had an impact in terms of increased revenues, and 5 projects have had an impact in terms of cost savings. As indicated in Figure 4.3, the products and processes associated with these projects generated total revenues and cost savings of about $53.9 million in 1991, including $53.2 million (98.7%) in revenues and $0.7 million (1.3%) in

cost savings. The value of the revenues and costs savings was up from $3.0 million in 1980, $19.6 million in 1985 and $44.0 million in 1990.

8. **However, only about 40% of the revenues and cost savings generated in 1991 are directly attributable to the Science Council funded projects.**

Proponents of the 96 projects which led to commercialization were surveyed to assess the importance of the Science Council funded project in the development of commercial products and processes, and to determine the likelihood that these products/processes still would have been commercialized even if the Science Council funded project had not been undertaken. For the purposes of this study, we will define attributable benefits as the economic benefits that would not have been realized if the Science Council funded projects had not been undertaken. For example, if a given product/process would still have had a 75% chance of being commercialized even if the Science Council funded project not been undertaken, the benefits directly attributable to the Science Council funded project are estimated to be equal to 25% (100% minus 75%) of the total economic benefits generated by commercialization of the product/process.

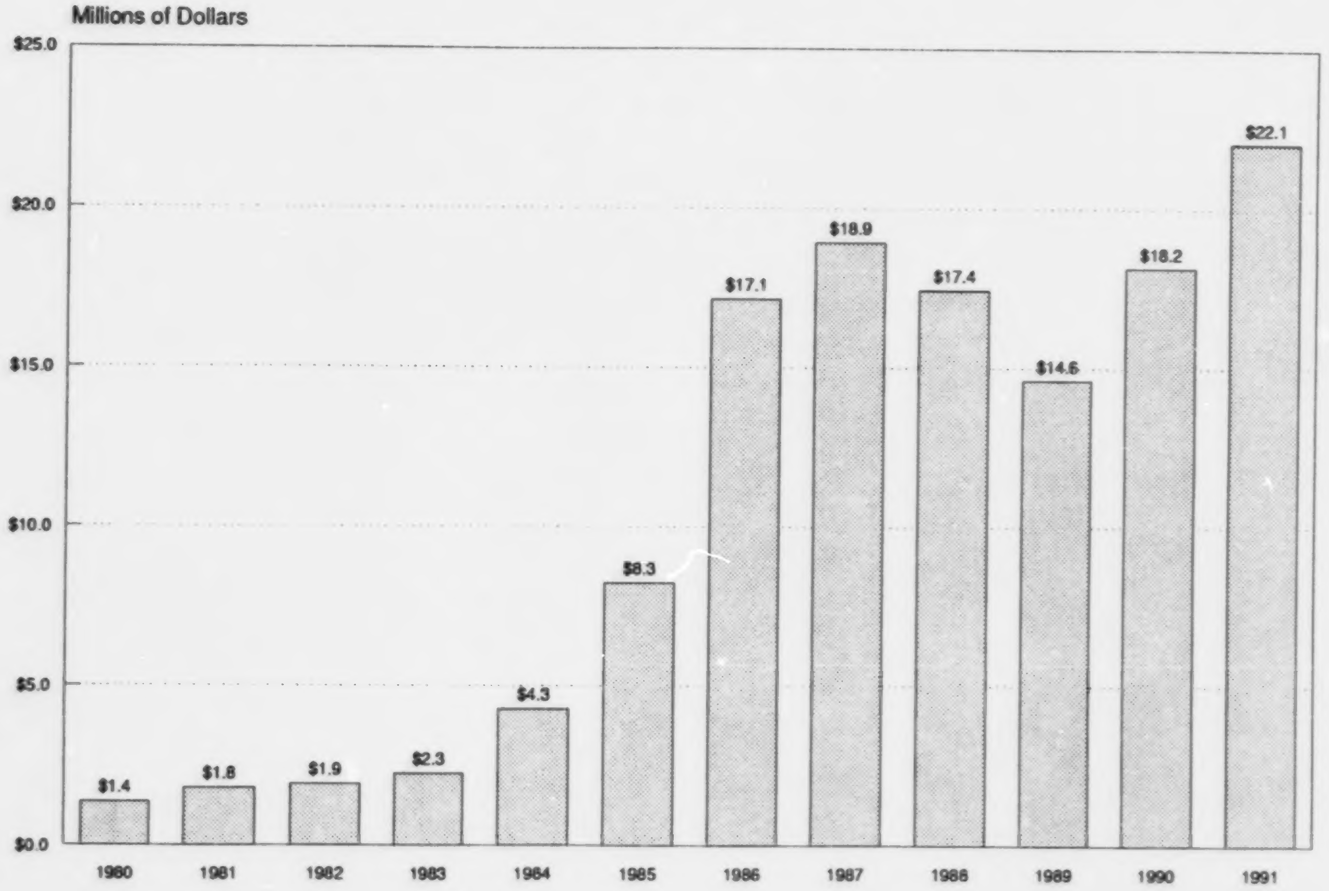
Based on in-depth interviews with the proponents, an estimate of the extent to which the benefits could be attributed to the results of each of the 96 projects was developed. In several instances, the level of attribution reported by the respondents was discounted when it appeared, based on discussions with the proponents and industry experts, likely that the product or process would have been developed even if the Science Council funded project had not been undertaken.

Using this methodology, it is estimated that revenues and cost savings directly attributable to the 96 Science Council funded projects totalled approximately $22.0 million in 1991, of which revenues represented $21.6 million (97.9%). These impacts were up from $0.8 million in 1980, $6.5 million in 1985 and $17.2 million in 1990.

9. **Export sales represented over 70% of the revenues directly attributable to the results of Science Council funded projects in 1991.**

The proponents of the 96 projects leading to commercialization were asked to provide a breakdown of sales for the resulting products/processes by geographic markets. As

Figure 4.4
ATTRIBUTABLE REVENUES/COST SAVINGS 1980-1991 (EXPRESSED IN 1991 DOLLARS)



indicated below, 72.6% of attributable revenues in 1991 were generated from customers outside Canada, which would tend to suggest that Science Council funding not only had an impact on the revenues of the proponents but also increased their ability to compete globally.

1991 REVENUES BY GEOGRAPHIC MARKETS

Market	1991 Revenues ($000)	Share
Lower Mainland	1,360	6.3%
Interior of B.C.	626	2.9%
Vancouver Island	648	3.0%
Other Canada	3,283	15.2%
Outside of Canada	15,679	72.6%
Total	21,596	100.0%

Source: Survey of 96 proponents of commercialized projects

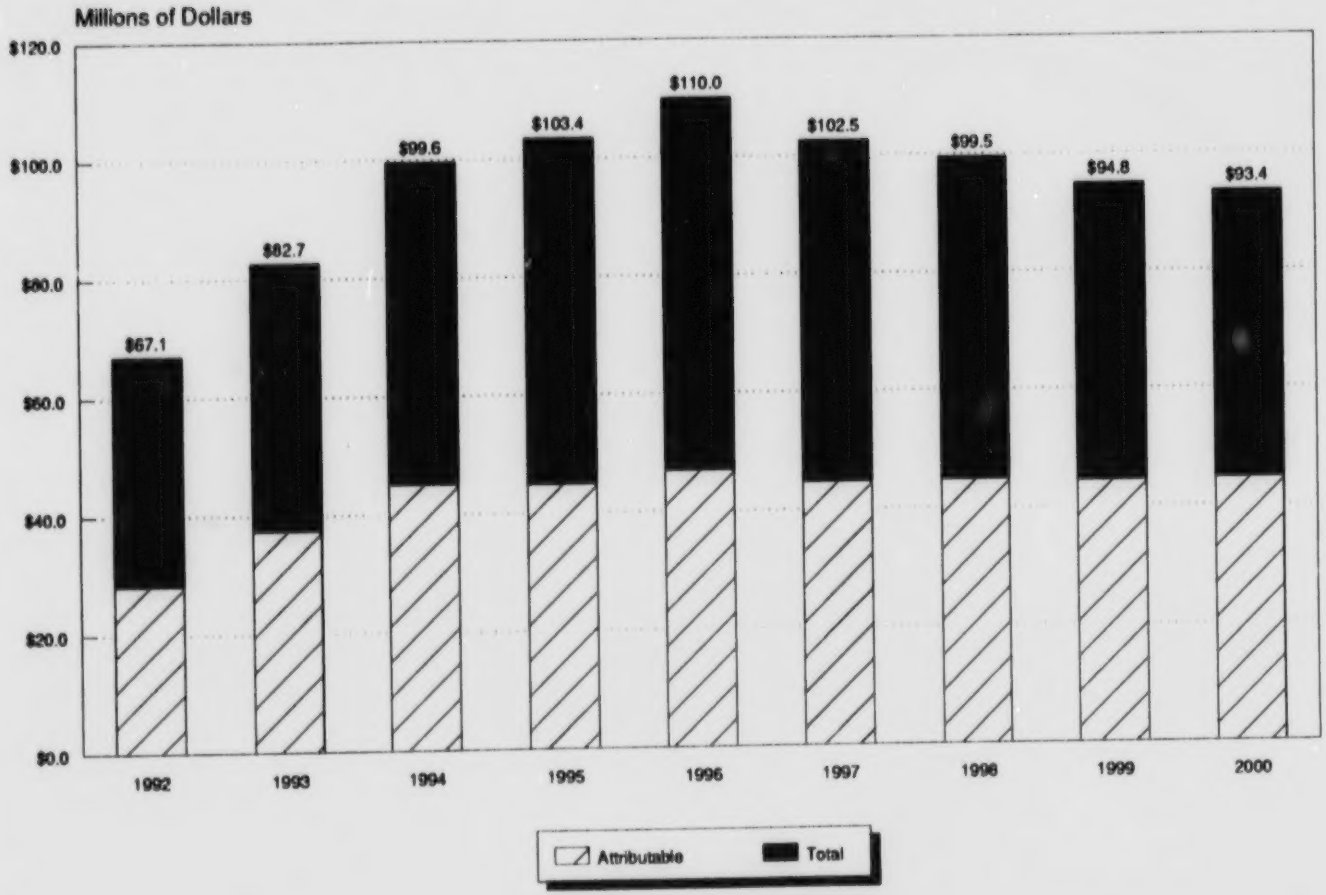
Primary export markets included the United States, Europe and Asia. Other major markets included Canadian provinces other than B.C. (15.2%) and the Lower Mainland (6.3%).

10. **The cumulative value of the attributable revenues and cost savings to date, expressed in 1991 dollars, is estimated to be $128.2 million.**

The benefits directly attributable to the 96 Science Council funded projects described above were adjusted to a common year (1991) using the Consumer Price Index (All Items) for British Columbia. As indicated in Figure 4.4, the revenues and cost savings directly attributable to the results of the Science Council projects, as expressed in 1991 dollars, rose from about $1.4 million in 1980 to $8.2 million in 1985, $18.1 million in 1990 and $22.0 million in 1991. The cumulative value of the attributable revenues and cost savings generated between 1980 and 1991 is estimated to be $128.2 million.

11. **Attributable revenues and cost savings are projected to grow by another $160.0 million between 1992 and the year 2000.**

Figure 4.5
IMPACT ON REVENUES/COST SAVINGS
AS PROJECTED BY RESPONDENTS, 1992-2000



Proponents of the 96 projects leading to commercialization were asked to develop projections regarding the future revenues and cost savings associated with their projects, based on the expected useful life of the products/processes involved. As indicated in Figure 4.5, total revenues and cost savings generated by these products/processes, as estimated by proponents, are expected to increase to $110.0 million in 1996 and then gradually decline to $93.4 million in the year 2000. Similarly, revenues and cost savings directly attributable to the results of these 96 projects are expected to increase to $46.9 million in 1996 and then slowly decline to $44.7 million in the year 2000.

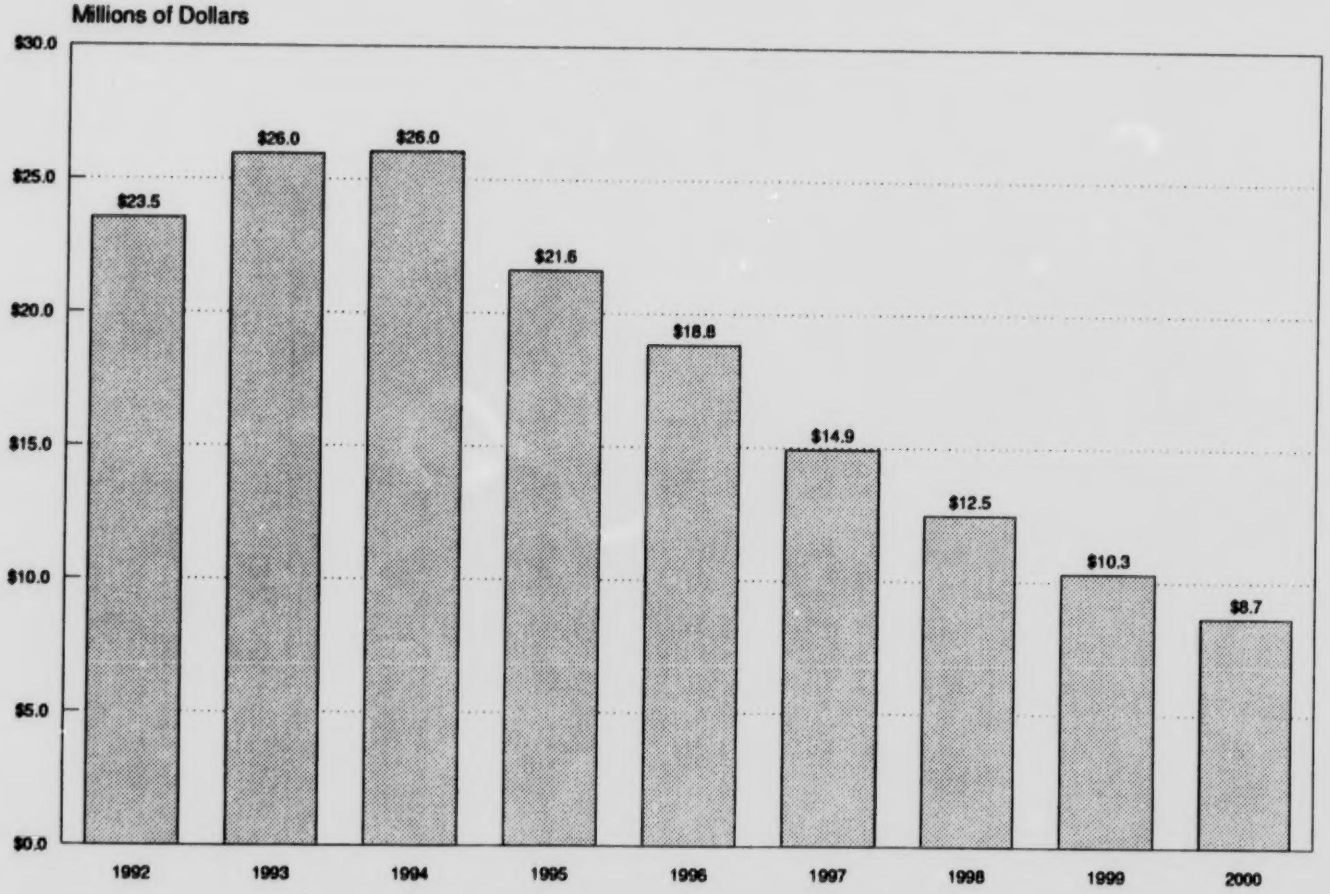
Because they are substantially higher than the benefits realized to date, and because of the very competitive nature of the advanced technology sector, the revenue and cost savings projections provided by the respondents were discounted at 20% per annum in order to account for inflation and for the level of risk associated with such long-term projections. Using this methodology, it is estimated that value of the attributable revenues and cost savings (expressed in 1991 dollars) will peak in 1994 at $26.0 million and then gradually decline to $18.8 million in 1996 and $8.7 million in the year 2000 as shown in Figure 4.6. The cumulative value of the attributable revenues and cost savings to be generated between 1992 and the year 2000 is projected to total $160.0 million.

12. **Attributable revenues and cost savings to date represent a return of between $2.11 and $4.34 per every dollar of Science Council funding provided.**

In order to compare the benefits achieved to the cost incurred, all AGAR and STDF contributions were restated and adjusted to a common year (1991) using the CPI. As indicated in Table 4.10, the 527 projects funded under AGAR and STDF received a total of $45.2 million in Science Council support between 1979 (RC-1) and 1989 (RC-20), which translates into $60.9 million in 1991 dollars. Similarly, the 300 projects in our sample received a total of $23.1 million in Science Council over the same period, which is equivalent to $29.5 million in 1991 dollars.

Therefore, the attributable revenues and cost savings to date ($128.2 million in 1991 dollars) represent a return of between $2.11 and $4.34 per every dollar of funding provided as shown in Table 4.11. The lower limit, computed on the basis of the funding received by all 527 projects, represents a worst case scenario and is based on the assumption that our sample of 300 projects captured all the projects commercialized to date. The upper

Figure 4.6
ATTRIBUTABLE REVENUES/COST SAVINGS
1992-2000 (PROJECTED IN 1991 DOLLARS)



limit, on the other hand, assumes that our evaluation did not obtain data on all the projects commercialized to date, and that an equal proportion of benefits was generated by projects not included in our sample of 300. Because commercialized projects to date were identified through a variety of sources, including a questionnaire mailed to proponents of all funded projects, the AGAR evaluation study undertaken in 1987, the STDF 88 "Evaluation" and a file review, we believe that the first case scenario is closer to the actual value than the second. If we assume, for example, that the survey has quantified 80% of the actual benefits to date, the revenues and costs savings attributable to the Science Council funded projects would be equal to $2.63 ($2.11 divided by 0.8) per dollar contributed under AGAR or STDF.

Including the current value of the projected revenues and costs savings to the year 2000, the revenues and cost savings attributable to the Science Council funded projects (estimated at about $290.6 million in 1991 dollars) represent a return of between $4.77 and $9.84 per every dollar of funding provided. Although future revenues and cost savings expressed by respondents were, as explained above, discounted at 20% per annum because of the risk inherent to such projections, it is difficult to determine whether the return achieved will be closer to the lower or upper limit. The return does not include the potential impacts of the 33 projects which may be commercialized in the next two to three years.

Impact on Profitability

13. **It is estimated that the pre-tax profits associated with the 96 projects leading to commercialization totalled $2.9 million in 1991.**

Proponents of the 96 projects leading to commercialization were surveyed to determine the level of pre-tax profits attributable to these projects since commercialization. As could be expected, 67 of the 96 proponents (69.8%) were either unable to break out the profitability of their product/process from that of the rest of their operation, or were unwilling to do so on the grounds of confidentiality. Furthermore, most of the 29 proponents responding were unable to provide a breakdown of the pre-tax profits year by year and only supplied information relating to their latest fiscal year (1991). Because of these limitations, the information derived from these 29 proponents, while useful, should be used with relative caution. The attributable pre-tax profits associated with these 29 projects were $1,036,000 in 1991, which represented about 13.3% of the attributable revenues ($7,759,000). By

Table 4.10

1991 VALUE OF SCIENCE COUNCIL CONTRIBUTIONS

		Projects Responding (300)		Total Project Population (527)	
Year	CPI (1991=100)	Funding Received ($000)	1991 Value ($000)	Funding Received ($000)	1991 Value ($000)
1979	50.2	114	227	1,531	3,050
1980	54.9	855	1,557	3,168	5,771
1981	62.8	1,114	1,774	4,776	7,606
1982	69.4	2,372	3,418	4,712	6,790
1983	73.1	1,309	1,791	3,390	4,638
1984	76.1	1,363	1,791	2,817	3,702
1985	78.4	1,662	2,120	3,211	4,095
1986	80.8	2,092	2,589	2,921	3,615
1987	83.2	1,921	2,309	3,417	4,107
1988	86.2	7,629	8,850	12,368	14,348
1989	90.1	2,754	3,057	2,860	3,174
Total		23,071	29,526	45,171	60,896

Source: Mail Survey of 300 Project Proponents
Science Council data for competitions RC-1 to RC-20 inclusive

Table 4.11

REVENUES/COST SAVINGS PER DOLLAR OF STDF-AGAR FUNDING

	To Date (1980-1991)			To the Year 2000 (1980-2000)		
	Attributable Revenues/ Cost Savings ($000)	Total Funding Received ($000)	Return Per Dollar of Funding	Attributable Revenues/ Cost Savings ($000)	Total Funding Received ($000)	Return Per Dollar of Funding
Minimum	$128,231	$60,896	$ 2.11	$290,577	$60,896	$ 4.77
Maximum	$128,231	$29,526	$ 4.34	$290,577	$29,526	$ 9.84

Source: Survey of 96 proponents of commercialized projects
Science Council data for competitions RC-1 to RC-20 inclusive

extrapolating these results, the pre-tax profits associated with the 96 projects leading to commercialization can be estimated to total approximately $2.9 million in 1991 (equal to 13.3% of $22.0 million). The cumulative net income between 1980 and 1991 would total approximately $17 million.

Impact on Capital Investment

14. **Over 50% of Science Council projects leading to commercialization also encouraged subsequent capital investment in B.C..**

Proponents of the 96 Science Council funded projects leading to commercialization were surveyed to determine whether their organizations had made any subsequent capital investment in B.C. with respect to the products/processes commercialized as a result of these projects. For the purposes of this study, we will define subsequent capital investment as investment which was not part of the Science Council funded project but which was stimulated by the success of the original project. As indicated below, 54 of the 96 projects leading to commercialization (54.2%) generated subsequent capital investment in B.C.

IMPACT ON CAPITAL INVESTMENT

Question: Has your organization made a capital investment in B.C. with respect to this product or process that is directly attributable to the results of the Science Council funded project ?

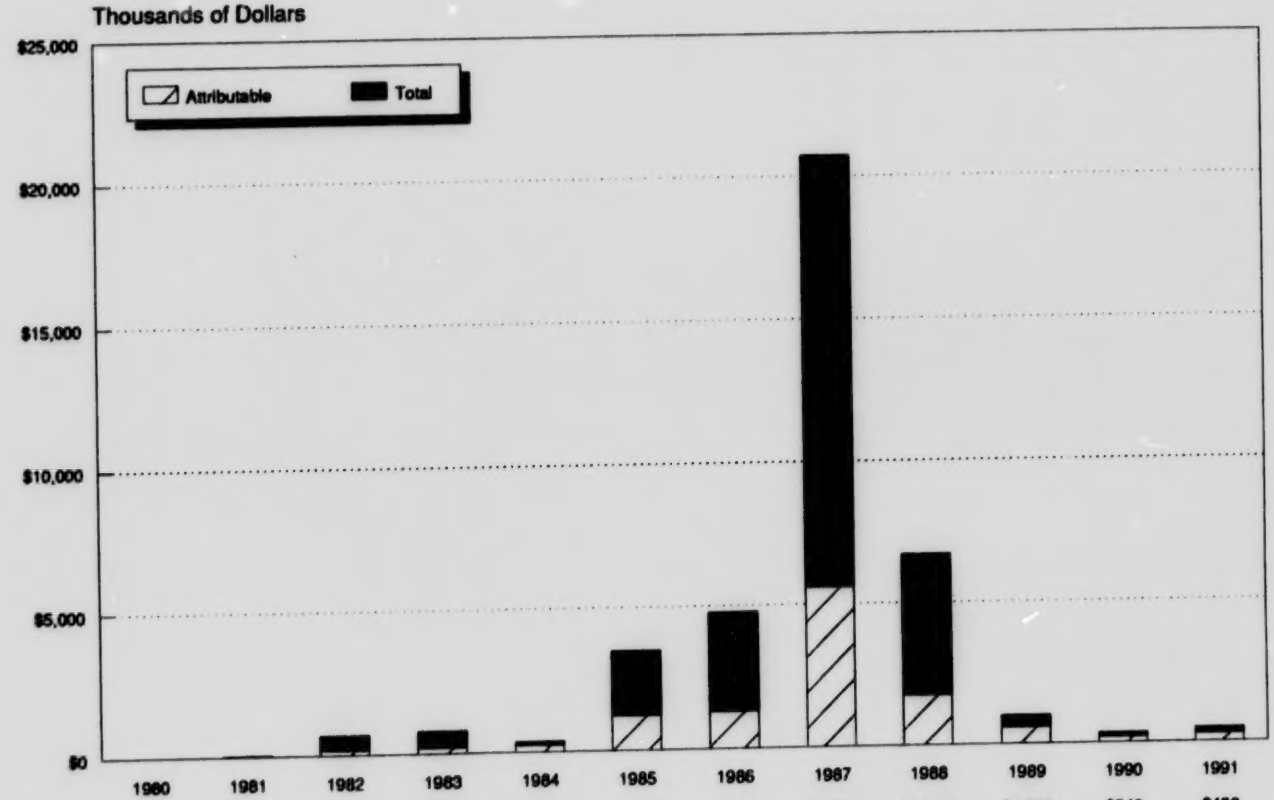
	Number of Respondents	Share
Yes	52	54.2%
No	37	38.5%
Don't know	7	7.3%
Total	96	100.0%

Source: Survey of 96 proponents of commercialized projects

15. **In 1991, the value of subsequent capital investments totalled $488,000.**

As indicated in Figure 4.7, capital investments made with respect to the products and processes developed with assistance from the Science Council have varied greatly over the last 10 years. Total investment in these products/processes increased from $40,000 in 1981

Figure 4.7
IMPACT ON CAPITAL INVESTMENT AS REPORTED BY RESPONDENTS, 1980-1991



	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Total	$0	$40	$700	$800	$360	$3,480	$4,780	$20,715	$6,698	$1,000	$340	$488
Attributable	$0	$20	$175	$200	$230	$1,215	$1,293	$5,593	$1,750	$569	$190	$269

to $800,000 in 1983, $4.8 million in 1986 and peaked in 1987 and 1988 at $20.7 million and $6.7 million respectively. It should be noted that these unusually high levels of capital investment in 1987 and 1988 were almost entirely the result of the construction of a $25.0 million infrastructure project (Science World B.C.) for which the planning study was funded by Science Council. Capital investments experienced a sharp declined after 1988 to $1.0 million in 1989 and $488,000 in 1991.

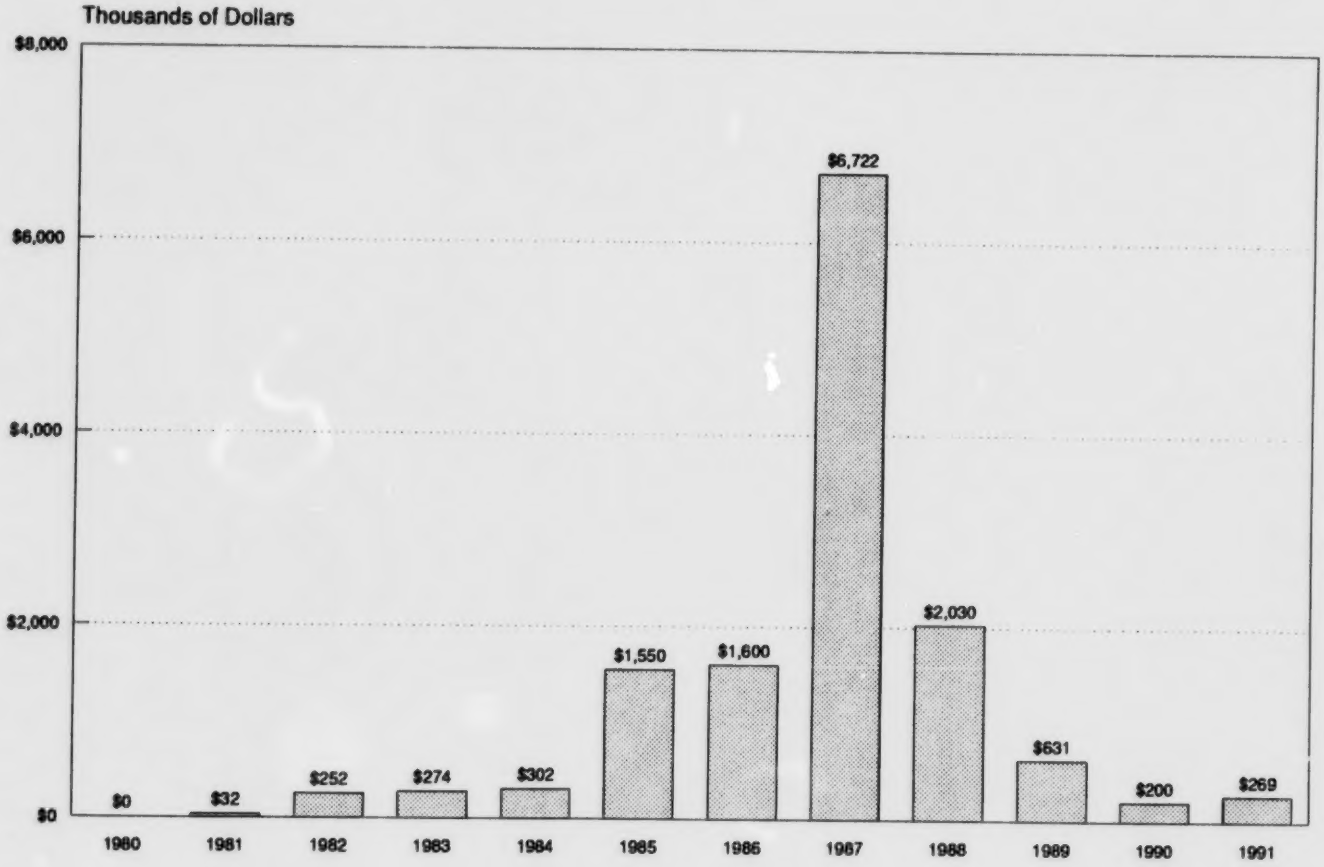
16. **However, only about 55% of the capital investments generated in 1991 were directly attributable to the Science Council funded projects.**

As indicated earlier, proponents of the 96 projects leading to commercialization were surveyed to assess the importance of the Science Council funded project in the development of commercial products and processes. Based on the information supplied, we reviewed the extent to which capital investments made with respect to the products/processes could be attributed to the results of each of the 96 projects for which they were the focus of the research. In several instances, attributable benefits as identified by respondents were discounted when it appeared that the capital investment would have been made even if the Science Council funded project had not been undertaken. Using this methodology, it is estimated that capital investments directly attributable to the 52 Science Council funded projects totalled about $269,000 in 1991. This was up from $20,000 in 1980 and down from $1.2 million in 1985 and $5.6 million in 1987.

17. **Attributable capital investments to date, expressed in 1991 dollars, are estimated at about $13.9 million.**

Using the same methodology as that employed for revenues and cost savings, capital investments directly attributable to the Science Council funded projects were adjusted to a common year (1991) using the CPI (All Items) for British Columbia. As indicated in Figure 4.8, capital investments directly attributable to the results of the Science Council projects, as expressed in 1991 dollars, rose from about $32,000 in 1981 to $1.6 million in 1985 and $6.7 million in 1987, and then gradually declined to $269,000 in 1991. Altogether, total attributable capital investments between 1980 and 1991 inclusive are estimated at $13.9 million. This amount may seem rather low, especially in light of the sizeable contribution made by the above-mentioned infrastructure project. However, one should keep in mind that only 54.2% of commercialized projects identified had an impact

Figure 4.8
ATTRIBUTABLE CAPITAL INVESTMENT
1980-1991 (EXPRESSED IN 1991 DOLLARS)



on capital investment and that, in many instances, the proponent's organization either already owned most of the equipment required to manufacture the product/process or entered into production and marketing agreements with third party organizations, thus limiting the amount of capital invested.

18. Attributable capital investments to date represent a return of between $0.23 and $0.47 per every dollar of Science Council funding provided.

As indicated above, the 527 projects funded under AGAR and STDF received a total of $45.2 million in Science Council support between 1979 (RC-1) and 1989 (RC-20), which translates into $60.9 million in 1991 dollars. Similarly, the 300 projects in our sample received a total of $23.1 million in Science Council over the same period, or an equivalent of $29.5 million in 1991 dollars.

Using the same methodology as that employed for attributable revenues and cost savings, attributable capital investments to date ($13.9 million in 1991 dollars) represent a return of between $0.23 and $0.47 per every dollar of funding provided, as indicated below.

CAPITAL INVESTMENTS PER DOLLAR OF STDF-AGAR FUNDING

	To Date (1980-1991)		
	Attributable Capital Investments ($000)	**Total Funding Received ($000)**	**Return Per Dollar of Funding**
Minimum	$13,862	$60,896	$0.23
Maximum	$13,862	$29,526	$0.47

Source: Survey of 96 proponents of commercialized projects
Science Council data for competitions RC-1 to RC-20 inclusive

If we assume, for example, that the survey has quantified 80% of the actual benefits to date, the subsequent capital investment attributable to the Science Council funded projects would be equal to $0.29 ($0.23 divided by 0.8) per dollar contributed under AGAR or STDF.

Table 4.12

IMPACT ON EMPLOYMENT

	Number Created	%	Number Maintained	%	Total	%
Total Impact:						
Jobs	636	100.0%	62	100.0%	698	100.0%
Full-Time Jobs	606	95.3%	62	100.0%	668	95.7%
Person-Years of Employment	2,674	-	376	-	3,050	-
Attributable Impact:						
Jobs	280	100.0%	29	100.0%	309	100.0%
Full-Time Jobs	266	95.0%	29	100.0%	295	95.5%
Person-Years of Employment	1,029	-	178	-	1,207	-
Attributable Full-Time Jobs:						
Research & Development	111	41.7%	20	69.0%	131	44.4%
Manufacturing	107	40.2%	4	13.8%	111	37.6%
Marketing	35	13.1%	3	10.3%	38	12.9%
Other	13	5.0%	2	6.9%	15	5.1%
Total	266	100.0%	29	100.0%	295	100.0%
Attributable 1991 Wages ($000):						
Research & Development	$4,079	44.3%	$854	72.2%	$4,933	47.5%
Manufacturing	3,288	35.7%	103	8.7%	3,391	32.6%
Marketing	1,317	14.3%	135	11.4%	1,452	14.0%
Other	523	5.7%	90	7.7%	613	5.9%
Total	9,207	100.0%	1,182	100.0%	10,389	100.0%

Source: Telephone Survey of 96 proponents of commercialized projects

Impact on Employment

19. **Over 80% of Science Council projects leading to commercialization had a direct impact on employment in British Columbia.**

Proponents of the 96 Science Council funded projects leading to commercialization were surveyed to determine whether any permanent B.C.-based jobs in their organizations had been created or maintained following the commercialization of the results of these projects. As indicated below, 77 of the 96 projects leading to commercialization (80.2%) had a direct impact on employment in B.C.

IMPACT ON EMPLOYMENT

Question: Can the creation or maintenance of any permanent B.C.-based jobs in your organization be attributed to the commercialization of this product or process (and attributable to the results of the Science Council funded project ?

	Number of Respondents	Share
Yes	77	80.2%
No	18	18.8%
Don't know	1	1.0%
Total	96	100.0%

Source: Survey of 96 proponents of commercialized projects

20. **The commercialization of products/processes which were the focus of Science Council funded projects has resulted in the creation or maintenance of about 700 employment positions to date.**

As indicated in Table 4.12, the commercialization of these products/processes resulted in the creation of 636 employment positions in B.C. to date, including 606 full-time positions. In addition, it has also enabled the maintenance of 62 existing employment positions, all full-time. Altogether, the commercialization of products/processes which were the focus of Science Council funded projects has resulted in over 3,000 additional person-years of employment to date.

21. The maintenance or creation of 309 of these employment positions (44%) were directly attributable to the Science Council funded projects.

Based on the information supplied by respondents, we reviewed the extent to the employment benefits generated by the commercialization of the products/processes could be attributed to the results of each of the 77 projects for which they were the focus of the research. In several instances, attributable benefits as identified by respondents were discounted when the product/process would have been commercialized even if the Science Council funded project had not been undertaken. Using this methodology, it is estimated that only 309 of the 698 employment positions created or maintained to date (44.3%) are directly attributable to the 77 Science Council funded projects, including 295 full-time positions. Altogether, about 1,200 additional person-years of employment to date are attributable to the results of Science Council funded projects.

22. The majority of attributable employment positions created or maintained to date were in research and development and manufacturing.

As indicated in Table 4.12, 131 of the 295 attributable full-time positions created to date (44.4%) involved research and development. Next in order of importance were manufacturing positions (111 positions or 37.6% of total) and marketing positions (38 positions). Other types of positions created or maintained included secretarial, administrative and service positions.

23. The total wages and benefits associated with the 295 full-time positions totalled $10.4 million in 1991.

As indicated in Table 4.12, the wages and benefits associated with the 295 full-time employment positions created or maintained to date were $10.4 million in 1991. Of this total, research and development positions accounted for $4.9 million (average of $37,660 per position), followed by manufacturing positions at $3.4 million ($30,550 per position) and marketing positions at $1.4 million ($38,210 per position). This impact in terms of wages and salaries paid in 1991 is thought to be conservative as it pertains only to full-time positions.

24. **The attributable employment impact to date represents between 0.48 and 1.00 full-time employment positions per every $100,000 of Science Council funding provided.**

Using the same methodology as that employed for attributable revenues/cost savings and capital investments, attributable employment to date (295 full-time positions and 1,207 person-years) represents between 0.48 and 1.00 full-time positions and between 1.98 and 4.09 additional person-years of employment per every $100,000 of funding provided, as indicated below.

EMPLOYMENT PER DOLLAR OF STDF-AGAR FUNDING

	To Date (1980-1991)		
	Attributable Employment	Total Funding Received ($000)	Return Per $100,000 of Funding
Full-Time Positions:			
Minimum	295	$60,896	0.48
Maximum	295	$29,526	1.00
Person-Years of Employment:			
Minimum	1,207	$60,896	1.98
Maximum	1,207	$29,526	4.09

Source: Survey of 96 proponents of commercialized projects
Science Council data for competitions RC-1 to RC-20 inclusive

If we assume that the survey has quantified 80% of the actual employment benefits to date, approximately 0.6 full-time positions and 2.5 person years of employment have been created for every $100,000 in funding contributed under AGAR and STDF.

Impacts on Other B.C. Organizations

25. **The majority of the 96 projects leading to commercialization have also had an economic impact on B.C. organizations other than their proponent's.**

The proponents of the 96 projects leading to commercialization were surveyed to determine whether the commercialization of the results of the projects had any economic impact on

Table 4.13

INDIRECT ECONOMIC IMPACTS ON OTHER B.C. ORGANIZATIONS

	Number Having Impact	%	Number Providing Estimate	Total Impact	Attri-butable Impact	%
Revenues ($000)	47	49.0%	29	$21,545	$8,591	39.9%
Cost Savings ($000)	22	22.9%	4	$5,560	$1,530	27.5%
Capital Investment ($000)	7	7.3%	2	$205	$102	49.8%
Employment (Full-time positions)	15	15.6%	5	19	6	31.6%

Source: Telephone Survey of 96 proponents of commercialized projects

B.C. organizations other than their own. As indicated below, 57 of the 96 projects leading to commercialization (59.4%) had an indirect economic impact on other B.C. organizations.

IMPACT ON OTHER B.C. ORGANIZATIONS

Question: To your knowledge, has commercialization of the product or process, based upon the results of the project, had any economic impact on other organizations in terms of revenues, cost savings, capital investment or employment ?

	Number of Respondents	Share
Yes	57	59.4%
No	32	33.3%
Don't know	7	7.3%
Total	96	100.0%

Source: Survey of 96 proponents of commercialized projects

26. **These impacts were mostly in the form of increased revenues and cost savings.**

Respondents of the 57 projects having an indirect economic impact on other B.C. organizations were surveyed to determine whether this impact was in the form of capital investment, revenues, cost savings, employment, or any combination of the above. As indicated in Table 4.13, 47 of the respondents (82.5%) indicated that their project had an impact on the revenues of other B.C. organizations such as suppliers and subcontractors. In addition, 22 respondents (38.6%) indicated that their project resulted in cost savings for other organizations, usually clients or users of the products/technology developed. By comparison, only 15 respondents indicated that their project had an indirect impact on employment and 7 that it had an indirect impact on capital investment. The latter numbers are likely to be conservative; while respondents can state with relative certainty whether their project impacted on the revenues of, say, a subcontractor, they may not be aware of the capital investments actually made by this subcontractor or of the employment positions created to fulfil his obligations vis-a-vis the product to be manufactured.

27. **The majority of respondents were unable to estimate the magnitude of these indirect impacts.**

Proponents of the 57 projects having an indirect economic impact on other B.C. organizations were asked, where possible, to provide an estimate of the magnitude of this impact. As indicated in Table 4.13, very few of the respondents were able to provide an estimate, with the notable exception of those reporting an indirect impact in terms of revenues. As indicated, 29 of these 47 respondents (61.7%) were able to provide an indication of the magnitude of the indirect impact of their project on the revenues of other organization.

The indirect impact on revenues, as estimated by the 29 proponents responding, totalled about $21.5 million in 1991, of which $8.6 million was directly attributable to the results of these 29 Science Council funded projects. Similarly, total indirect impact on cost savings, as estimated by the 4 proponents responding, was about $5.6 million in 1991, of which $1.5 million was directly attributable to these 4 projects. Total indirect impacts in terms of capital investments were $205,000 to date, of which $102,000 was attributable to the 2 projects providing an estimate. Finally, a total of 19 full-time indirect employment positions were generated by the 5 projects whose proponents provided an estimate, including 6 positions which are directly attributable to these projects.

28. In order to gain a better understanding of the indirect impacts generated to date, 5 mini-case studies were conducted on projects having broad industry applications.

Under AGAR and STDF, funding has been provided for some projects which were designed to further the development of a new process or technology that could be applied by many organizations and operations, rather than by just the proponent. Five mini-case studies involving such projects were conducted over the course of this study in order to obtain an indication of the magnitude of the benefits generated to date by these projects. The 5 projects which were the focus of these 5 mini-case studies were as follows:

- Case Study #1: Fish Pumps for the Fishing Industry
- Case Study #2: Pheromones for the Forest Industry
- Case Study #3: Plant Introduction Scheme for the Nursery Industry
- Case Study #4: Development of a Honeybee Package and Queen Industry
- Case Study #5: Improved Production Techniques for the Oyster Industry

The main findings of these 5 mini-case studies are summarized in the following paragraphs. For confidentiality purposes, the benefits accruing to the project proponent and their organizations are not presented and only benefits accruing to their respective sector overall are discussed.

Case Study #1: Fish Pumps for the Fishing Industry

Richmond-based Innovac Technology received $79,200 in AGAR funding in 1982 towards the development of a range of wet vacuum fish pumps which transfer fish from one location to another more efficiently and with less damage than other systems previously used by fishing industry, particularly dry vacuum systems.

First marketed in 1982 to the west coast fishing industries of B.C. and Alaska, the company's pumps and related product lines are now used around the world. Originally envisioned as a dockside installation at processing plants, pumps have now gained an overwhelming industry acceptance and have also been installed on packers (transfer boats), unloading depots anchored on the fishing grounds (scows), unloading wharves, and even on larger seiners. According to the 4 industry representatives contacted for the purposes of this mini-case study, the Innovac fish pumps have literally revolutionized fish handling in B.C. and displaced alternate unloading and transfer systems previously used. The pumps provide 3 major types of benefits to the users.

- Increased productivity

  Fishing vessels usually transfer their catch to packers (transfer boats), which in turn transport the fish to processing plants. Because of the much higher unloading rate of the Innovac pumps versus other systems, transfer time between the fishing vessel and the packer, and between the packer and the processing plant, are reduced considerably, enabling a much more effective use of the capacity of both the fishing vessel and the packer fleet.

- Lower handling costs

  According to the 4 industry representatives surveyed, the use of the Innovac fish pumps is much less labour and/or capital intensive than more traditional unloading and transfer systems such as siphon-caisson and braille systems. Although none of the representatives would confirm the figure of $0.02 in labour savings per pound of fish handled mentioned in the 1987 AGAR evaluation study, all agreed that these savings were undoubtedly substantial.

- Improved quality and market value of fish

  Because the Innovac fish pumps cause comparatively less damage to the fish than other systems, a larger volume of fish is available for sale and B.C. fishing companies can direct more first choice fish to the fresh and frozen market as long as servicing of the canned market will permit. Because the fresh and frozen markets usually return $0.20 to $0.40 more per pound of fish than the canned market, the use of the fish pumps also results in increased revenues for the industry. The magnitude of the increased revenues could not be estimated by the 4 representatives contacted.

The 4 industry representatives contacted was not able to quantify the economic impact of the Innovac fish pumps on the B.C. fishing industry. However, Innovac estimates the total impact to be between $5.0 million and $7.0 million per year. In addition, the commercialization of the pumps also has an indirect impact of about $2.0 million to $3.0 million per year on the revenues of local suppliers. Total impacts of the technology could increase dramatically in the future, as it is currently being adapted to new uses including aquaculture, food processing and oil-spill clean-up.

Case Study #2: Pheromones for the Forest Industry

Through grants to UBC and SFU-based researchers and to Delta-based Phero Tech Inc. totalling about $765,000 between 1979 and 1989, new methods to control the spread of 2 major forest pests (Mountain Pine Beetle and Ambrosia Beetle) were developed. Researchers have identified the chemical structures of the substances the insect use to attract one another, and have developed ways to produce synthetic attractants (pheromones), and traps to lure insects away from valuable timber.

The Mountain Pine Beetle lure has been used by the B.C. Ministry of Forests since 1984/1985 as one method to control small outbreaks and to prevent spread of the infestation in specific instances (alternative methods include clear cutting). The Ambrosia Beetle lures are offered to forest companies by Phero Tech as part of a monitoring service; the intention of the program is to reduce beetle damage to logs by interpreting data on the number of beetles trapped in the bait lures, and formulating inventory control programs which minimize the time of storage during periods of high infestation, store only low value logs in areas where infestation is the most severe, etc... About 50% of all dryland and wet sort sites in B.C. currently subscribe to this service. Indeed, the recent market emphasis on higher value sawmilling end-products has enhanced the industry's willingness to pay for such protective measures, all the more so since potential damage to high value logs considerably outweighs the cost of controlling pest infestation. In addition to maintaining the value of their forest inventories, the Ambrosia program also enables forest companies to retain these inventories over a longer period of time.

While unable to provide detailed estimates of the economic impact of the pheromones lures on the B.C. forest industry in terms of revenues, the 3 industry representatives surveyed indicated that the latter was "substantial" and probably in the tens of millions of dollars annually. Indeed, according to a 1983 study entitled "Economic Significance of Agricultural Insects" (H. Gerber, H.F. Madsen), the damage due to Ambrosia beetle infestation and associated loss of industry revenues was about $64.7 million in 1980-1981, of which 50% could be recaptured through mass trappings of these beetles using pheromones. Similarly, it was estimated that about 15,681,000 m^3 of wood was attacked by Mountain Pine beetles in 1981, of which 4,216,614 m^3 (26.9%) was lost, translating into a loss in revenues of $358.4 million for the B.C. forest industry (based on an export value of $85 per m^3).

Case Study #3: Plant Introduction Scheme for the Nursery Industry

The University of British Columbia Botanical Garden received a total of $344,912 in AGAR funding between 1982 and 1986 for its Plant Introduction Scheme (PIS). Plant species which are deemed commercially attractive for resale in Canada, the United States and other export markets are brought to the Botanical Garden for detailed evaluation, where they are tested for their growth rate, hardiness and adaptability to soil and climate. If deemed suitable for release, they are then provided to participating nurseries for multiplication and resale on a contract-royalty basis.

A total of 11 new plant varieties have been introduced to date through the PIS, with the first 4 introductions occurring in 1984. Altogether, about 5 million plants have been propagated as a result of the program, including over 4 million plants in B.C. The number of participating B.C. nurseries increased from 9 in 1985 to 42 in 1991. In addition, 10 to 15 nurseries located abroad (U.S., New Zealand and Japan) also participate in the PIS. Five B.C. nurseries, representing about 50% of the sales attributable to the 11 releases to date, were surveyed for the purposes of this mini-case study to determine the economic impact of the PIS on the industry. As indicated below, total sales generated by the PIS program increased steadily between 1984 and 1991, from $164,000 to $880,000, and should continue to increase at a rate of 10% to 15% per annum in the foreseeable future.

IMPACT ON THE B.C. NURSERY INDUSTRY

Year	Total Revenues	Attributable Revenues	Total Employment	Attributable Employment
1984	$ 164,000	$ 82,000	2.5	1.2
1985	254,600	127,300	3.9	1.9
1986	437,800	218,900	6.6	3.3
1987	455,800	227,900	6.9	3.4
1988	566,000	283,000	8.6	4.3
1989	690,000	345,000	10.5	5.2
1990	800,000	400,000	12.1	6.0
1991	880,000	440,000	13.3	6.6

Source: Survey of 5 B.C. participating nurseries

The impact on employment was estimated using the results of a 1991 study undertaken by Ference Weicker and Company on behalf of the B.C. Nursery Trades Association entitled "Profile of the B.C. Nursery Industry". According to the study, wages represent an average of 27.3% of sales for B.C. nurseries and hourly wages average about $9.00 ($18,000 per year). Based on these figures, it is estimated that a total of 13 full-time equivalent positions have been created to date, up from 2 positions in 1984. Discussions with representatives of the Botanical Garden indicated, however, that only 50% of these benefits were directly attributable to the Science Council funding received.

It should also be noted that all 5 industry representatives surveyed, while acknowledging the impact of the PIS on industry revenues, believed that the intangible impacts of the program far outweighed any direct economic benefits achieved to date. In particular, the PIS was credited by all for "placing the B.C. industry on the map" and for turning it into a successful, export-oriented and generally more professional industry.

Case Study #4: Development of a Honeybee Package and Queen Industry

In the early 1980s, a large number of bee keepers in Western Canada and the Prairies, faced with the high cost of wintering the bees, were instead restocking their hives every spring by importing package bees from California. An opportunity was thus identified to produce bees to supply honey producers in Western Canada and reduce their dependence on imports from the U.S. To this end, a researcher at Simon Fraser University received a total of $114,250 in AGAR funding between 1982 and 1984 to develop procedures for raising package bees and queens suitable the B.C. conditions, and to supplement them with stock selection to provide a suitable genetic background.

The production of package bees and queens in B.C. thus began in 1984 and sales rapidly increased from $30,000 that year to about $515,000 in 1987, helped along the way by the discovery of a parasite in Californian bees which made them weaker and increased their mortality. Spurred by the discovery of yet another parasite in Californian bees and by the northward spread of the Africanized killer bees, Canada decided to ban all U.S. imports effective January, 1988, a measure that is still in effect today. Indeed, this ban created a major expansion opportunity for the B.C. bee breeding industry and the production of queens more than doubled in 1988 (from 20,750 queens in 1987 to 54,860 queens). Accordingly, revenues more than doubled to about $1.2 million in 1988, as indicated below.

IMPACT ON THE B.C. BEE BREEDING INDUSTRY

Year	Total Revenues	Attributable Revenues	Total Employment	Attributable Employment
1984	$ 30,000	$ 22,500	1.0	0.7
1985	60,000	45,000	3.0	2.2
1986	200,000	150,000	5.0	3.7
1987	515,000	386,250	8.0	6.0
1988	1,247,000	935,250	25.0	18.7
1989	926,000	694,500	15.0	11.2
1990	631,000	473,250	15.0	11.2
1991	614,000	460,500	15.0	11.2

Sources: B.C. Ministry of Agriculture and Fisheries
B.C. Bee Breeders Association.

In subsequent years, however, Prairie bee keepers began to adopt new management techniques involving wintering and to produce their own queens, which effectively reduced their dependence on B.C. as a source of supply for both package and queen bees. Accordingly, B.C. industry revenues experienced a gradual decline to $926,000 in 1989 and $614,000 in 1991, and the number of industry participants decreased from about 50 in 1988 to about 20 in 1991, employing about 15 people on a full-time basis. The 3 industry representatives and experts contacted for the purposes of this mini-case study were confident that industry revenues have now stabilized and will remain at their current level in the short term, or possibly experience an increase because of the, as yet, untapped market potential in the U.S.

Case Study #5: Improved Production Techniques for the Oyster Industry

Redonda Sea Farms in Desolation Sound received a total of $143,000 in AGAR funding between 1982 and 1983 to try novel methods of encouraging oyster larvae to settle on artificial substrates (long thin corrugated tubes). The plastic pipes are then transferred to deep water for grow out. Excess spat are removed after initial grow-out and oysters are re-immersed on racks for final grow-out. Essentially, this technology shortens turn-around time, so that oysters may be harvested more frequently than before (a market-size oyster can now be obtained in 14 months versus 24 months previously). First implemented by Redonda in 1984/85, this technology is now being used, with minor modifications, by the entire B.C. oyster industry.

According to the 3 industry representatives surveyed for the purposes of this mini-case study, the use of this technology has enabled their operations to increase production without increasing labour costs. It was noted that traditional methods calling for oyster seeds to be grown in the wild are both unpredictable and costly. By contrast, the technology developed at Redonda provides for a more reliable and predictable process and has enabled their operations to increase production volumes by 50% or more while keeping labour costs to a minimum. Two of the three respondents indicated that their labour costs are only 25% or 50% of what they would have been under traditional techniques, resulting in annual labour savings of $100,000 to $200,000 per operation. It is estimated that increased production levels have, nevertheless, resulted in the creation of over 50 new jobs in the industry.

D. INDIRECT BENEFITS

The evaluation issue developed with respect to the other indirect impacts of the Science Council funded projects is as follows:

Issue 2.4: **What other indirect benefits and impacts (both positive and adverse) can be attributed to projects which received funding from AGAR, and STDF, and how are they affecting intended impacts and the achievement of objectives?**

In order to identify their indirect impacts, we conducted a review of files for projects approved under AGAR, STDF and STDF-AGAR. Additional information concerning the indirect impacts of these projects was obtained through 2 mail surveys distributed respectively to the proponents of all Science Council projects and to Peer Review Committee members, and was supplemented by interviews with proponents of projects leading to commercialization, and with government and program representatives. The findings of our evaluation as they relate to this evaluation issue are summarized below:

Impact on Technical Knowledge

1. **Science Council funded projects have generally increased the technical knowledge of their proponents.**

The 300 proponents to our mail questionnaire indicated that the completion of the Science Council funded project had generally increased their understanding and knowledge of the technology at the core of the product or process being developed. In 39 instances, proponents indicated that the project yielded completely unexpected but nevertheless very valuable results, which either revealed a much broader field of applications and/or confirmed or refuted previous empirical beliefs and theories concerning that technology.

This increase in technical knowledge is also reflected in the high proportion of projects deemed technically successful by their proponents. Although only 96 of the 300 projects have generated direct commercial benefits to date, 182 projects (60.7%) were deemed "successful" or "extremely successful" in accomplishing their technical objectives, and only 26 projects (8.7%) were deemed "not very" or "not at all successful" in this respect. On a scale of 1 to 5 (where 1 is "not at all successful, 3 is "moderately successful" and 5 is "extremely successful"), the average rating was 3.73 as indicated below:

ACHIEVEMENT OF TECHNICAL OR RESEARCH OBJECTIVES

Question: On a scale of 1 to 5 (where 1 is "Not at all Successful", 3 is "Moderately Successful", and 5 is "Extremely Successful"), how successful was the project in accomplishing its technical or research objectives ?

		Number of Respondents	Share
Not at all successful	1	6	2.0%
Not very successful	2	20	6.7%
Moderately successful	3	74	24.7%
Successful	4	125	41.6%
Extremely successful	5	57	19.0%
No response		18	6.0%
Total		300	100.0%

Average Response: 3.73

Source: Survey of 300 project proponents

Impact on Training

2. Science Council funded projects assisted in the training of research and development personnel.

Table 4.14

IMPACT ON WILLINGNESS TO INVEST IN RESEARCH AND DEVELOPMENT

Question: Did this project, for which you received funding from the Science Council, have a major impact, a minor impact or no impact in terms of the willingness of your organization to invest in research and development ?

	Major Impact (3)	%	Minor Impact (2)	%	No Impact (1)	%	Don't Know/ No Response	%	Total	%	Average Impact
By Type:											
Industry	51	68.0%	48	55.8%	22	27.5%	9	16.4%	130	44.0%	2.24
University	18	24.0%	24	27.9%	48	60.0%	46	83.6%	136	45.9%	1.67
Non-Profit	6	8.0%	14	16.3%	10	12.5%	0	0.0%	30	10.1%	1.87
Total	75	100.0%	86	100.0%	80	100.0%	55	100.0%	296	100.0%	1.98
By Sector:											
Agriculture & Food	6	8.1%	6	7.0%	6	7.5%	9	15.5%	27	9.1%	2.00
Aquatic Resources	6	8.1%	13	15.1%	8	10.0%	5	8.6%	32	10.7%	1.92
Biotechnology	1	1.4%	3	3.6%	2	2.5%	1	1.7%	7	2.3%	1.83
Computers & Computing	6	8.1%	7	8.1%	5	6.2%	3	5.2%	21	7.0%	2.06
Electronics & Communications	17	23.0%	9	10.5%	8	10.0%	9	15.5%	43	14.4%	2.26
Energy	7	9.4%	14	16.3%	9	11.2%	8	13.8%	38	12.8%	1.93
Forestry & Forest Products	18	24.3%	18	20.9%	23	28.8%	16	27.6%	75	25.2%	1.91
Health Technology	2	2.7%	2	2.3%	2	2.5%	0	-	6	2.0%	2.00
Manufacturing & Machinery	8	10.8%	12	13.9%	7	8.8%	3	5.2%	30	10.1%	2.04
Mining, Minerals & Metals	3	4.1%	2	2.3%	10	12.5%	4	6.9%	19	6.4%	1.53
Total	74	100.0%	86	100.0%	80	100.0%	58	100.0%	298	100.0%	1.98

Source: Survey of 300 project proponents.

Although no attempt was made to measure the number of persons receiving specialized training while working on Science Council funded projects, a large majority of the project proponents and peer review committee members surveyed for the purposes of this study indicated that Science Council funded projects had a major impact in terms of training. It was noted that many individuals acquired valuable training, experience and expertise while working on Science Council funded projects which, in many instances, have enabled them to continue working in the same area of expertise after completion of the project.

Impact on Willingness to Invest in Research and Development

3. **Science Council funded projects favourably impacted on the willingness of proponent organizations to invest in research and development.**

The 300 respondents to our mail questionnaire were asked to rank, on a scale of 1 to 3 (where 1 is "No Impact", 2 is "Minor Impact" and 3 is "Major Impact"), the impact of the Science Council funded project on their organization's willingness to invest in research and development. As indicated in Table 4.14, 31.1% of respondents expressing an opinion indicated that their project had a "major" impact and an additional 35.7% indicated that it had a "minor impact". The remaining 33.2% of respondents stated that the project had no impact at all in this regard. These were generally representatives from organizations which were already heavily involved in research and development. The average ranking was 1.98.

As indicated in Table 4.14, the impact on private sector businesses was comparatively larger than that on universities. Indeed, 42.1% of proponents of industry-sponsored projects indicated that their project had a "major" impact, versus only 20.0% for both university-based projects and projects involving non-profit organizations. Overall, the average impact was highest for industry sponsored-projects (2.24), followed by projects involving non-profit organizations (1.87) and universities (1.67). These results are not surprising insofar as universities are already strongly committed to research and development activities. The results do suggest, however, that Science Council funded projects have reinforced their willingness to conduct research in selected areas.

In terms of areas of expertise, the average impact tended to be higher amongst projects related to electronics/communications (2.26), computers/computing (2.06) and

Table 4.15

IMPACT ON RESEARCH CAPABILITIES

Question: **Did this project, for which you received funding from the Science Council, have a major impact, a minor impact or no impact in terms of the research capabilities of your organization ?**

	Major Impact (3)	%	Minor Impact (2)	%	No Impact (1)	%	Don't Know/ No Response	%	Total	%	Average Impact
By Type:											
Industry	55	50.5%	53	51.4%	12	31.6%	10	21.7%	130	44.0%	2.36
University	46	42.2%	32	31.1%	22	57.9%	36	78.3%	136	45.9%	2.24
Non-Profit	8	7.3%	18	17.5%	4	10.5%	0	-	30	10.1%	2.13
Total	109	100.0%	103	100.0%	38	100.0%	46	100.0%	296	100.0%	2.28
By Sector:											
Agriculture & Food	10	9.3%	8	7.8%	3	7.9%	6	12.2%	27	9.1%	2.33
Aquatic Resources	11	10.2%	11	10.7%	6	15.8%	4	8.2%	32	10.7%	2.18
Biotechnology	3	2.8%	4	3.9%	0	-	0	-	7	2.3%	2.43
Computers & Computing	10	9.3%	6	5.8%	3	7.9%	2	4.1%	21	7.0%	2.37
Electronics & Communications	19	17.6%	13	12.6%	4	10.5%	7	14.3%	43	14.4%	2.42
Energy	10	9.3%	17	16.5%	3	7.9%	8	16.3%	38	12.8%	2.23
Forestry & Forest Products	25	23.1%	25	24.3%	11	28.9%	14	28.6%	75	25.2%	2.23
Health Technology	4	3.6%	1	1.0%	1	2.6%	0	-	6	2.0%	2.50
Manufacturing & Machinery	13	12.0%	13	12.6%	2	5.3%	2	4.1%	30	10.1%	2.39
Mining, Minerals & Metals	3	2.8%	5	4.8%	5	13.2%	6	12.2%	19	6.4%	1.85
Total	108	100.0%	103	100.0%	38	100.0%	49	100.0%	298	100.0%	2.28

Source: Survey of 300 project proponents manufacturing/machinery (2.04) and lower for projects related to mining/minerals/metals (1.53) and biotechnology (1.83).

Impact on Research Capabilities

4. **Science Council funded projects have generally enhanced the research capabilities of proponent organizations.**

The 300 respondents to our mail questionnaire were also asked to rank, on a scale of 1 to 3, the impact of the Science Council funded project on their organization's research capabilities. As indicated in Table 4.15, 43.6% of respondents expressing an opinion indicated that their project had a "major" impact and an additional 41.2% indicated that it had a "minor impact". The remaining 15.2% of respondents stated that the project had no impact at all. The average ranking was 2.28.

The impact on private sector businesses was comparatively larger than that on universities and non-profit organizations. As indicated in Table 4.15, 45.8% of proponents of industry-sponsored projects indicated that their project had a "major" impact, versus 46.0% for university-sponsored projects and only 26.7% for projects involving non-profit organizations. Overall, however, the average impact was highest for industry sponsored-projects (2.36), followed by university-sponsored projects (2.24) and projects involving non-profit organizations (2.13). It should be noted that the impact did not vary significantly between economic sectors.

Science Council funded projects did, indeed, have a strong impact on the research capabilities of private sector proponents. In particular, many such proponents indicated that their organization was a fledgling start-up at the time it first received Science Council funding, and that this funding enabled the organization to assemble a team of qualified researchers and/or to develop valuable knowledge for application in various products and processes. Furthermore, where the results of the Science Council funded project have been successfully commercialized, the associated revenues generally facilitated the transition from a small start-up to a more established company with strengthened research capabilities.

Table 4.16

IMPACT ON LEVEL OF COOPERATION

Question: Did this project, for which you received funding from the Science Council, have a major impact, a minor impact or no impact in terms of the level of cooperation between your organization and others with respect to the development of this product or process ?

	Major Impact (3)	%	Minor Impact (2)	%	No Impact (1)	%	Don't Know/ No Response	%	Total	%	Average Impact
By Type:											
Industry	36	40.9%	48	45.7%	29	55.8%	17	33.3%	130	44.0%	2.06
University	42	47.7%	40	38.1%	21	40.4%	33	64.7%	136	45.9%	2.20
Non-Profit	10	11.4%	17	16.2%	2	3.8%	1	2.0%	30	10.1%	2.28
Total	88	100.0%	105	100.0%	52	100.0%	51	100.0%	296	100.0%	2.15
By Sector:											
Agriculture & Food	9	10.3%	11	10.5%	2	3.8%	5	9.3%	27	9.1%	2.32
Aquatic Resources	9	10.3%	9	8.6%	9	17.3%	5	9.3%	32	10.7%	2.00
Biotechnology	1	1.1%	4	3.8%	2	3.8%	0	-	7	2.3%	1.86
Computers & Computing	5	5.8%	6	5.6%	7	13.5%	3	5.5%	21	7.0%	1.89
Electronics & Communications	12	13.8%	15	14.3%	8	15.4%	8	14.8%	43	14.4%	2.11
Energy	10	11.5%	15	14.3%	5	9.7%	8	14.8%	38	12.8%	2.17
Forestry & Forest Products	25	28.7%	28	26.7%	9	17.3%	13	24.1%	75	25.2%	2.26
Health Technology	2	2.4%	2	1.9%	1	1.9%	1	1.8%	6	2.0%	2.20
Manufacturing & Machinery	8	9.2%	11	10.5%	7	13.5%	4	7.4%	30	10.1%	2.04
Mining, Minerals & Metals	6	6.9%	4	3.8%	2	3.8%	7	13.0%	19	6.4%	2.33
Total	87	100.0%	105	100.0%	52	100.0%	54	100.0%	298	100.0%	2.15

Source: Survey of 300 project proponents.

Impact on Level of Cooperation

5. **Science Council funded projects have fostered greater cooperation between proponent organizations and other organizations.**

One of the objectives of the AGAR and STDF programs was to encourage scientific and technological research in B.C. in a manner that would create greater linkages between research organizations (particularly universities and non-profit organizations) and businesses who could apply the findings of the research. The 300 respondents to our mail questionnaire were asked to assess the impact of the Science Council funded project on the level of cooperation between their organization and others with respect to the product/process being developed. As indicated in Table 4.16, 35.9% of respondents expressing an opinion indicated that their project had a "major" impact and an additional 42.9% indicated that it had a "minor impact". The remaining 21.2% of respondents stated that the project had no impact. The average ranking was 2.15. These results would tend to suggest that the AGAR, STDF and STDF-AGAR programs have indeed been successful in increasing the level of cooperation between industry and research institutions.

The impact was comparatively larger for non-profit organizations and universities than for private sector businesses. As indicated in Table 4.16, 40.8% of proponents of university-sponsored projects indicated that their project had a "major" impact, versus 34.5% for projects involving non-profit organizations and 31.9% for industry-sponsored projects. Overall, however, the average impact was highest for projects involving non-profit organizations (2.28), followed by university-sponsored projects (2.20) and industry-sponsored projects (2.06). Here again, there were no major variations between economic sectors.

Some of the university and not-for-profit proponents surveyed indicated that increased cooperation with the private sector had enabled their research to be more commercially focused than it may have been otherwise. Similarly, a number of private sector proponents indicated that increased cooperation with universities had enabled their organization to access valuable knowledge and research capabilities not available internally.

Impact on Competitiveness

6. **Science Council funded projects have enabled numerous private businesses to develop or maintain a competitive edge and be recognized for their technological leadership.**

A large majority of private sector proponents surveyed indicated that increasing global competition and the current economic recession have increased the need for and costs and risks associated with research and development. Because they were non-repayable, Science Council contributions effectively reduced both the cost and risks associated with specific research and development projects, and were also, in numerous instances, used to leverage financing from other sources. As a result, Science Council funding, aside from generating economic benefits, also enabled a number of organizations to secure a position on the leading by conducting research which otherwise would have been too costly, risky or lengthy to undertake .

This increased competitiveness has in turn contributed to the diversification of the B.C. economy by reinforcing the infrastructure related to science and technology, and by strengthening the research, production and marketing abilities of proponent organizations.

Impact on Awareness of Research and Development Activities

7. **Science Council funded projects have contributed to a greater awareness of the Science Council and raised the profile of research and development in B.C.**

Because their results have been broadly disseminated through publications, conferences and seminars and personal contact, Science Council funded projects have, according to many proponents and peer review committee members surveyed, fostered a much greater awareness of the Science Council and its activities and raised the profile of research and development in British Columbia.

Impacts on the Public

8. **A number of Science Council funded projects have also benefited the public at large, through environmental, health and safety improvements.**

A number of projects, including but not limited to those producing direct commercial benefits, have benefited the public at large in the areas of environment, health and safety. Because they are intangible in nature, these benefits are very difficult if not impossible to quantify. Their importance, however, cannot be understated. For example, while only 6 of the 75 forestry projects in our sample of 300 have generated commercial benefits to date, many have produced intangible benefits, including better forest management practices and cleaner and more efficient mill operations. Similarly, a number of projects in the electronics and health technology sectors have benefited the public in various ways, resulting, for example, in improvements in the detection or cure of various conditions, or in increased independence for people with physical disabilities.

E. INCREMENTALITY

The evaluation issue developed which respect to the extent to which the projects were incremental (would not have occurred without Science Council funding) is as follows:

Issue 2.5: To what extent have the projects funded under AGAR and STDF and the resulting impacts and effects been incremental (would not have been realized without AGAR or STDF funding)?

Information concerning the likelihood that the projects would have been implemented even without Science Council funding was obtained through a mail questionnaire distributed to proponents of all funded projects, and supplemented by in-depth interviews with proponents of projects leading to commercialization. In addition, 50 proponents of rejected or withdrawn applications were surveyed to determine whether their proposed project went ahead in the absence of Science Council funding. The findings of our evaluation with respect to incrementality are summarized below:

1. **On average, projects leading to commercialization would have had a 40% chance of going ahead without Science Council funding.**

   The 300 proponents responding to our mail questionnaire and the 96 proponents of projects leading to commercialization were surveyed to identify the extent to which the projects and their associated benefits were incremental (would not have been implemented without funding from the Science Council). As indicated in Table 4.17, only 13 of the 96 projects leading to commercialization (13.5%) would definitely not have gone ahead in the absence

Table 4.17

INCREMENTALITY OF SCIENCE COUNCIL FUNDED PROJECTS

Question 1: **If no funding, or only 50% of the funding provided by the Science Council, had been received, how likely is it that the project would still have gone ahead in some form ?**

Question 2: **If the project may still have gone ahead, would the absence of Science Council funding have likely:**

- **Created no change in the timing or the scope of the research**
- **Delayed completion of the project**
- **Reduced the scope of the project**
- **Delayed completion and reduced the scope of the project**

	NO FUNDING				50% OF THE FUNDING			
	All Projects		Commercialized Projects		All Projects		Commercialized Projects	
	Number	%	Number	%	Number	%	Number	%
Question 1								
No chance at all (0%)	67	22.3%	13	13.5%	42	14.0%	5	5.2%
Unlikely (25%)	133	44.3%	35	36.5%	85	28.3%	23	24.0%
Even chance (50%)	48	16.0%	28	29.2%	81	27.0%	22	22.9%
Likely (75%)	23	7.7%	17	17.7%	38	12.7%	29	30.2%
Definitively would (100%)	9	3.0%	3	3.1%	20	6.7%	10	10.4%
No Response	20	6.7%	0	-	34	11.3%	7	7.3%
Total	300	100.0%	96	100.0%	300	100.0%	96	100.0%
Average Response:	30%		40%		41%		54%	
Question 2								
No change in timing or scope	5	2.1%	3	3.6%	8	3.1%	9	9.9%
Delayed project completion	22	9.4%	28	33.7%	14	5.4%	17	18.7%
Reduced project scope	17	7.3%	6	7.3%	24	9.3%	7	7.7%
Delayed completion and reduced scope	135	58.0%	46	55.4%	132	51.1%	51	56.0%
Other	4	1.7%	0	-	1	0.5%	0	-
No response	50	21.5%	0	-	79	30.6%	7	7.7%
Total	233	100.0%	83	100.0%	258	100.0%	91	100.0%

Sources: Survey of 300 project proponents
Survey of 96 proponents of commercialized projects

of Science Council funding. An additional 35 projects (36.5%) would have had a 25% chance of going ahead. Only 3 projects (3.1%) would have still "definitely gone ahead". On average, projects leading to commercialization would have had a 40% chance of going ahead without Science Council funding.

By comparison, 67 of the 300 projects in our sample (22.3%) would not have gone ahead in the absence of Science Council funding. An additional 133 projects (44.3%) would have had a 25% chance of going ahead. On average, the 300 projects in our sample would have had a 30% chance of going ahead without Science Council funding. It would appear, therefore, that projects which eventually lead to commercialization are somewhat more likely to go ahead without funding from the Science Council than are projects which don't lead to commercialization.

In order to assess the impact of no AGAR or STDF funding on total project expenditures, we developed a weighted average for incrementality using total project costs to weight the responses. Using a weighted average, 53% of the project expenditures are incremental (47% were not). The weighted average is lower than the simple average of 70% because, as would be expected, the projects which received proportionately less funding from the Science Council were more likely to go ahead without Science Council funding. However, as will be discussed in the next point, the weighted average tends to underestimate the extent to which the project expenditures are incremental because no adjustments have been made to reflect the fact that projects may have been reduced in scope or delayed in the absence of Science Council funding.

2. **Most projects would have had to be delayed or reduced in scope, or both, in order to still go ahead in the absence of Science Council funding.**

Proponents who indicated that their project may still have gone ahead in the absence of Science Council funding were surveyed to identify the form that their project would have taken if no funding had been provided by AGAR or STDF. Of the 83 projects ultimately leading to commercialization which may still have gone ahead, only 3 projects (3.6%) would not have experienced any change in timing or scope. By comparison, 28 projects (33.7%) would have been delayed, 6 projects (7.3%) would have been reduced in scope, and 46 projects (55.4%) would have been both delayed and reduced in scope.

Table 4.18

PROPORTION OF RESEARCH AND DEVELOPMENT EXPENDITURES[1] WHICH ARE INCREMENTAL BY TYPE OF PROPONENT

Type of Proponent	Actual[2]	Assuming No Funding Provided by Science Council[2]	% Not Incremental	% Incremental
All:				
• Funded by Science Council	$1.00	$0.00	0%	100%
• Funded by Other Sources	2.09	1.15	55	45
• Total Project Expenditures	$3.09	$1.15	37%	63%
Universities and Colleges:				
• Funded by Science Council	$1.00	$0.00	0%	100%
• Funded by Other Sources	1.44	0.95	66	34
• Total Project Expenditures	$2.44	$0.95	39%	61%
Not-for-Profit Organizations:				
• Funded by Science Council	$1.00	$0.00	0%	100%
• Funded by Other Sources	2.64	1.03	39	61
• Total Project Expenditures	$3.64	$1.03	28%	72%
Industry (Private Sector)				
• Funded by Science Council	$1.00	$0.00	0%	100%
• Funded by Other Sources	2.58	1.34	52	48
• Total Project Expenditures	$3.58	$1.34	37%	63%

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[1] - Figures are expressed per $1.00 of Science Council funding provided under AGAR and STDF.

[2] - Based on survey of proponents of 300 projects.

Similarly, of the 233 projects which may still have gone ahead in our sample, only 5 projects (2.1%) would not have experienced any change in timing or scope. By contrast, 22 projects (9.4%) would have been delayed (by about one year), 17 projects (7.3%) would have been reduced in scope (project expenditures would have been reduced to about 70% of actual) and 135 projects (58.0%) would have been both delayed and reduced in scope.

Based upon the responses provided by proponents, adjustments were made to the weighted average measure for incrementality to account for the likely change in timing (project expenditures were discounted at the rate of 6% per year) and scope. Using this methodology, it is estimated that 63% of the project expenditures are incremental (would not have occurred without funding from AGAR or STDF) and 37% were not incremental (they would have occurred in any event). According to our survey results, approximately $2.09 in project funding was invested from other sources for every dollar awarded under AGAR or STDF. In the absence of funding from AGAR or STDF, the level of investment from other sources would have declined to $1.15 (per dollar actually contributed under AGAR or STDF); therefore, 45% of the amount invested from other sources was incremental (it would not have been invested in this research and development project in the absence of Science Council funding) as indicated in Table 4.18.

Table 4.18 also outlines the incrementality of the research and development expenditures by type of proponent. As indicated, the proportion of the total project expenditures which were incremental ranged from 61% for projects sponsored by proponents from universities and colleges to 72% for projects sponsored by not-for-profit organizations. The proportion of funding from other sources which was incremental tended to be higher amongst projects sponsored by not-for-profit and private sector organizations than by proponents associated with universities and colleges.

These results would tend to suggest that the Science Council contributions played two major roles in stimulating applied research and development:

- In many instances, the Science Council provided a source of funding for project proponents who would otherwise have had difficulty in raising the funding necessary for research purposes, either internally or externally;

Table 4.19

LEADING SOURCES OF FUNDING AVAILABLE IN THE ABSENCE OF SCIENCE COUNCIL FUNDING

Question: If funding had not been provided by this program, what other funding sources may have been available for the project ?

	All Projects		Commercialized Projects	
	Number	%	Number	%
EMR	3	1.0%	0	-
FRB	1	0.3%	1	1.0%
Internal Funds	21	7.0%	17	17.7%
ISTC/DIPP/MSDP/STP	8	2.7%	2	2.1%
NRC/IRAP	24	8.0%	22	22.9%
NSERC/CRD/IOR	41	13.7%	5	5.2%
Private Funds	20	6.7%	6	6.2%
WED	3	1.0%	4	4.2%

Sources: Survey of 300 project proponents
Survey of 96 proponents of commercialized projects

- The funding provided by the Science Council also lowered the effective cost of the research and development projects for proponents. The lower cost associated with the project made them appear more attractive to proponents, who may not otherwise have gone ahead with the projects because of the perceived risk and competing priorities for their capital.

3. **Leading sources of funding that may have been available in the absence of Science Council funding included IRAP and the proponent organization's internal funds.**

Proponents were asked what other funding sources may have been available for the project in the absence of Science Council funding. As indicated in Table 4.19, other possible funding sources for projects leading to commercialization included IRAP (22.9%), the proponent organization's internal funds (17.7%), and private funds from commercial lenders and/or industry (6.2%). Similarly, leading alternative sources of funding for the 300 projects in our sample included NSERC (13.7%), IRAP (8.0%), the proponent organization's internal funds (7.0%) and private funds from commercial lenders and/or industry (6.7%).

4. **On average, the projects leading to commercialization would have had a 54% chance of going ahead, if only half the funding actually awarded had been received from the Science Council.**

As was indicated in Table 4.17, only 5 of the 96 projects leading to commercialization (5.2%) would definitely not have gone ahead if only 50% of the funding had been received. An additional 23 projects (24.0%) would have had a 25% chance of going ahead and 10 projects (10.4%) would have still "definitely" gone ahead. On average, projects leading to commercialization would have had a 54% chance of going ahead if only half the funding had been received, as compared to a 40% chance of going ahead without any funding at all.

Similarly, 42 of the 300 projects in our sample (14.0%) would definitely not have gone ahead if only half the funding had been received. An additional 85 projects (28.3%) would have had a 25% chance of going ahead and 20 projects (6.7%) would have still "definitely" gone ahead. On average, the 300 projects in our sample would have had a 41% chance of going ahead even if only half the funding had been received.

Table 4.20

STATUS OF REJECTED PROJECT APPLICATIONS

Question 1: **Was part or all of the proposed project implemeted, even though funding was not obtained ?**

Question 2: **If implemented, was the scope and the timing of the project the same as proposed in the AGAR, STDF or STDF-AGAR application ?**

- **Created no change in the timing or the scope of the research**
- **Delayed completion of the project**
- **Reduced the scope of the project**
- **Delayed completion and reduced the scope of the project**

	Number of Respondents	%
Question 1		
Yes	35	70.0%
No, project was postponed	5	10.0%
No, project was cancelled	10	20.0%
Total	50	100.0%
Question 2		
No change in timing or scope	6	17.1%
Delayed project completion	17	48.6%
Reduced project scope	3	8.6%
Delayed completion and reduced scope	9	25.7%
Total	35	100.0%

Source: Telephone survey of 50 proponents of rejected applications

5. **A survey of 50 rejected and withdrawn applications confirmed the reasonableness of the information supplied by project proponents with respect to the incrementality issue.**

In order to obtain additional information on program incrementality and to verify the reasonableness of the information supplied by proponents with respect to this issue, we conducted a survey of proponents of 50 rejected and withdrawn applications to determine whether or not these projects had been implemented in the absence of Science Council funding. Of these 50 projects, 35 (70.0%) have been implemented to date, 5 (10.0%) have been postponed until other sources of funding can be secured, and 10 (20.0%) have been cancelled as indicated in Table 4.20.

Leading funding sources accessed by the 35 projects implemented in the absence of Science Council funding included private funds from commercial lenders and industry (28.6% of respondents), the proponent organization's internal funds (22.9%), IRAP (11.4%), the B.C. Ministry of Forests (8.6%) and the Western Economic Diversification Program (5.7%). Only 6 of the 35 implemented projects (17.1%) went ahead with the same scope and timing as proposed in the AGAR, STDF or STDF-AGAR application. By contrast, 17 projects (48.6%) were delayed (average delay of 14 months), 3 projects (8.6%) were reduced in scope and 9 projects (25.7%) were both delayed and reduced in scope.

These results would tend to suggest that the information supplied by proponents of projects leading to commercialization with respect to incrementality is actually conservative. Indeed, the proportion of rejected/withdrawn projects which went ahead in the absence of Science Council funding (70.0%) is lower than that expressed by proponents of projects leading to commercialization (86.5%) and than that expressed by all 300 project proponents surveyed (77.7%).

6. **Although the projects may have been delayed or reduced in scope, over 85% of the attributable economic benefits were generated by projects which may have been undertaken even without support from the Science Council.**

Table 4.21

BREAKDOWN OF BENEFITS GENERATED, BY PROJECT STATUS WITHOUT SCIENCE COUNCIL FUNDING

	Status of Project Without Science Council Funding					
	Cancelled	Delayed	Reduced	Delayed & Reduced	No Change	Total
Number of Projects	13	28	6	46	3	96
Funding Received ($000)	$ 1,005	$ 3,272	$ 1,696	$ 7,416	$ 168	$ 13,557
Revenues/Cost Savings ($000)						
To Date (1980-1991)	$ 2,482	$ 43,750	$ 7,959	$ 73,274	$ 768	$ 128,233
Projected (1992-2000)	32,301	39,062	7,475	81,415	2,093	162,346
Total	34,783	82,812	15,434	154,689	2,861	290,579
Capital Investment ($000)	$ 201	$ 10,308	$ 225	$ 3,015	$ 111	$ 13,860
Employment						
Number of Jobs Created/Maintained	12	76	31	188	3	309
Number of FT Jobs Created/Maintained	10	70	30	184	1	295
Person Years of Employment to Date	25	388	162	627	6	1,208
Wages Paid in 1991 ($000)	$ 330	$ 2,402	$ 858	$ 6,767	$ 33	$ 10,390

Sources: Survey of proponents of 96 commercialized projects
Note: All dollar amounts are expressed in 1991 dollars

Based on the responses provided by proponents of the 96 projects leading to commercialization, the attributable benefits generated by each project were assigned to one of 5 categories, as follows:

- Projects that would not have gone ahead at all (cancelled) without Science Council support;
- Projects which would have been delayed without Science Council support;
- Projects that would have been reduced in size or scope without Science Council support;
- Projects that would have been both delayed and reduced in size or scope without Science Council support;
- Projects which would have proceeded without Science Council support, with no change in timing or in scope.

Table 4.21 summarizes the data collected on each project for each of these 5 groups. As indicated, only 13 projects (13.5%) would definitely not have gone ahead (would have been cancelled) without Science Council support. These 13 projects accounted for:

- 7.4% of the approved Science Council contributions;
- 1.9% of the revenues and cost savings to date;
- 12.0% of the revenues and cost savings to the year 2000;
- 3.9% of the jobs created and/or maintained to date;
- 3.4% of the full-time jobs created and/or maintained to date;
- 2.1% of the person years of employment created to date;
- 3.2% of the associated wages paid in 1991.

7. **However, about 65% of the economic benefits generated to date were incremental in that they would not have occurred without funding from the Science Council.**

The questionnaire used for proponents of projects leading to commercialization was designed to obtain information, where relevant, on the following:

Table 4.22

INCREMENTAL BENEFITS GENERATED BY SCIENCE COUNCIL FUNDED PROJECTS

	Status of Project Without Science Council Funding							
	Cancelled	Delayed	Reduced	Delayed & Reduced	No Change	Total	All Projects	Percent Incremental
Number of Projects	13	28	6	46	0	93	96	96.9%
Revenues/Cost Savings ($000)								
To Date (1980-1991)	$ 2,482	$ 19,737	$ 6,457	$ 54,221	$ 0	$ 82,897	$ 128,233	64.6%
Projected (1992-2000)	32,301	21,659	5,507	56,438	0	115,905	162,346	71.4%
Total	34,783	41,396	11,964	110,659	0	198,802	290,579	68.4%
Capital Investment ($000)	$ 201	$ 6,715	$ 153	$ 2,048	$ 0	$ 9,117	$ 13,860	65.8%
Employment								
Number of Jobs Created/Maintained	12	38	24	153	0	227	309	73.5%
Number of FT Jobs Created/Maintained	10	34	24	150	0	218	295	73.9%
Person Years of Employment to Date	25	177	133	498	0	833	1,208	68.9%
Wages Paid in 1991 ($000)	$ 330	$ 1,089	$ 693	$ 5,459	$ 0	$ 7,571	$ 10,390	72.9%

Sources: Survey of proponents of 96 commercialized projects
Note: All dollar amounts are expressed in 1991 dollars

- The impact of a delay or reduced scope on the resulting impacts. The intention was to develop an estimate of the percentage of benefits that would still have been realized in the absence of Science Council funding.

- The length of the delay. The remaining benefits were then adjusted by the length of the delay using the CPI.

Based on this information, the incremental benefits (those which would not have occurred without Science Council funding) of each individual project were then computed as follows:

- The value of the benefits attributable to the project (expressed, where appropriate, in 1991 dollars);

Less:

- The probability that the project would have gone ahead without Science Council funding;

- Times the value of the benefits (expressed, where appropriate, in 1991 dollars) that would still have been realized in the absence of Science Council funding. This value took into account any impacts that a reduction in scope or a delay in the project would have had on the resulting benefits.

Using this methodology, it is estimated that $82.9 million of the $128.2 million (64.6%) in revenues and cost savings generated to date are incremental in that they would not have been generated without Science Council funding as indicated in Table 4.22. Conversely, only $45.3 million in revenues and cost savings would have been generated in the absence of Science Council funding. Similarly, it is estimated that $9.1 million of the $13.9 million (65.8%) in capital investments generated to date are incremental in that they would not have occurred without Science Council funding.

The questionnaire used for proponents of projects leading to commercialization was not designed to provide information on the employment generated year by year but instead was designed to provide an aggregate estimate of the number of positions and person years of

employment created to date. As such, it was impossible to measure the impact of a delay or a reduced scope on the resulting benefits in terms of employment. Instead, it was assumed that, for each project, the incrementality factor for revenues and cost savings generated to date was the same as that for employment benefits. Using this methodology, it is estimated that about 70% of benefits in terms of employment were incremental in that they would not have been generated in the absence of Science Council funding.

These incremental benefits should be considered an upper limit for two reasons:

- Despite our best efforts, respondents may tend to over-estimate the likelihood that the project would not have gone ahead, or would have been delayed or reduced in scope, in the absence of AGAR or STDF funding.
- If these projects had been cancelled, it is possible that the funding contributed by the proponent organization may have been reallocated to alternative research and development projects. These projects may have generated revenues, cost savings, capital investments and employment positions, thereby reducing the net incremental benefits achieved by the Science Council funding.

Taking these factors into consideration, we estimate that between 55% (85% of maximum) and 65% of the revenues, cost savings and capital investments generated to date were truly incremental. Similarly, we estimate that between 60% and 74% of the benefits generated to date in terms of employment were truly incremental. Based upon our experience, these results are believed to be slightly above average for a program of this nature.

F. PROFILE OF PROJECTS LEADING TO COMMERCIAL BENEFITS

The evaluation issues developed with respect to the profile of projects leading to commercial benefits and to the major constraints to commercialization are as follows:

Issue 2.6: **What are the characteristics of the projects and proponents which have proven most successful in terms of promoting further economic development in British Columbia?**

Table 4.23

PROFILE OF PROJECTS LEADING TO COMMERCIALIZATION

	Projects Having an Impact on Revenues/ Cost Savings		Projects Having an Impact on Capital Investment		Projects Having an Impact on Employment		All Commercial Projects		All Projects Responding (300)	All Funded Projects (527)
	Number	%	Number	%	Number	%	Number	%	%	%
By Type of Proponent:										
Industry	64	66.7%	38	73.1%	51	66.2%	64	66.7%	43.3%	41.3%
University	26	27.1	11	21.1	20	26.0	26	27.1	45.3%	50.9%
Non-Profit	6	6.2	3	5.8	6	7.8	6	6.2	11.4%	7.8%
Total	96	100.0	52	100.0	77	100.0	96	100.0	100.0%	100.0%
By Sector:										
Agriculture & Food	8	8.3%	6	11.5%	7	9.1%	8	8.3%	9.0%	11.0%
Aquatic Resources	12	12.5	10	19.2	9	11.7	12	12.5	10.7%	15.5%
Biotechnology	1	1.0	0	-	0	-	1	1.0	2.3%	1.4%
Computers & Computing	8	8.3	2	3.8	5	6.5	8	8.3	7.0%	7.0%
Electronics & Communications	30	31.2	18	34.6	28	36.4	30	31.2	14.3%	13.0%
Energy	5	5.3	2	3.8	4	5.2	5	5.3	12.7%	9.3%
Forestry & Forest Products	6	6.3	1	2.0	4	5.2	6	6.3	25.0%	22.7%
Health Technology	0	-	0	-	0	-	0	-	2.0%	0.7%
Manufacturing & Machinery	20	20.8	11	21.1	16	20.8	20	20.8	10.0%	9.3%
Mining, Minerals & Metals	5	5.3	1	2.0	3	3.8	5	5.3	6.3%	9.1%
Other	1	1.0	1	2.0	1	1.3	1	1.0	0.7%	1.0%
Total	96	100.0	52	100.0	77	100.0	96	100.0	100.0%	100.0%
By Location of Proponent:										
Lower Mainland	77	80.2%	37	71.2%	62	80.5%	77	80.2%	na	85.2%
Interior	3	3.1	2	3.8	2	2.6	3	3.1	na	1.2%
Vancouver Island	16	16.7	13	25.0	13	16.9	16	16.7	na	13.6%
Total	96	100.0	52	100.0	77	100.0	96	100.0	100.0%	100.0%
By Size of Revenues (1):										
Less than $100,000	na	na	na	na	na	na	7	17.5%	na	23.4%
$100,000 to $199,999	na	na	na	na	na	na	8	20.0	na	12.4%
$200,000 to $499,999	na	na	na	na	na	na	1	2.5	na	9.8%
$500,000 to $999,999	na	na	na	na	na	na	13	32.5	na	18.6%
$1,000,000 to $1,999,999	na	na	na	na	na	na	4	10.0	na	11.7%
$2,000,000 to $9,999,999	na	na	na	na	na	na	5	12.5	na	13.8%
$10,000,000 or greater	na	na	na	na	na	na	2	5.0	na	10.3%
Total	na	na	na	na	na	na	40	100.0	100.0%	100.0%
By Number of Employees (2):										
0 to 4	na	na	na	na	na	na	13	25.5%	na	20.5%
5 to 9	na	na	na	na	na	na	7	13.8	na	20.5%
10 to 19	na	na	na	na	na	na	12	23.5	na	20.0%
20 to 49	na	na	na	na	na	na	11	21.6	na	14.0%
50 to 199	na	na	na	na	na	na	4	7.8	na	15.0%
200 to 499	na	na	na	na	na	na	4	7.8	na	5.0%
500 or greater	na	na	na	na	na	na	0	-	na	5.0%
Total	na	na	na	na	na	na	51	100.0	100.0%	100.0%

Sources: Survey of proponents of 96 commercialized projects
Survey of 300 project proponents
File review

Note (1): Because of incomplete project applications, the information presented is based on 40 of the 96 commercialized projects and 145 of the 527 funded projects.
Note (2): Because of incomplete project applications, the information presented is based on 51 of the 96 commercialized projects and 200 of the 527 funded projects.

Issue 2.7: **Where commercialization of the product or process associated with the project has not resulted or has been unsuccessful, what have been the constraining factors?**

In order to identify the characteristics of the most successful projects in terms of economic impact, and the main constraints to commercialization, we cross-tabulated the results of the surveys by various project characteristics such as type of proponent, location, and size of operation. Results were also tabulated by economic sector but the latter set of data should be taken with relative caution. Indeed, several committees were only created after 1985 and projects in these sectors have had comparatively less time to generate economic impacts. Furthermore, a number of projects in various sectors have generated intangible benefits which, while difficult to quantify, probably far exceed their tangible economic impacts. With these considerations in mind, the findings of our evaluation as they relate to these evaluation issues are summarized below:

Type of Projects Leading to Commercial Benefits

1. **Industry-sponsored projects were the most likely to lead to commercialization and represented over 65% of all commercialized projects.**

   Table 4.23 provides a breakdown of all projects leading to commercialization by type of proponent, economic sector, location, size of revenues, and number of employees. As indicated, industry-sponsored projects, which accounted for only 41.3% of all projects funded under AGAR or STDF, were the most likely to lead to commercialization and comprised 66.7% of all commercialized projects. By comparison, university-sponsored projects, which accounted for 50.9% of all funded projects, represented only 27.1% of all commercialized projects.

   These results did not vary significantly by type of impacts. Indeed, industry-sponsored projects represented 66.7% of all projects generating revenues and/or cost savings, 73.1% of projects generating capital investments and 66.2% of projects having an impact on employment.

2. **Projects in the electronics/communications and manufacturing/machinery sectors were the most likely to lead to commercialization and represented over 60% of all commercialized projects.**

As indicated in Table 4.23, projects in the electronics/communications sector (as defined as projects recommended by the Electronics and Communication Peer Review Committee), which accounted for 13.0% of all projects funded under AGAR or STDF, were the most likely to lead to commercialization and represented 31.2% of all commercialized projects, followed by projects in the manufacturing/machinery sector (20.8%) and the aquatic resources sector (12.5%).

Again, these results did not vary significantly by types of impacts. Projects in the electronics/communications and manufacturing/machinery sectors represented respectively 31.2% and 20.8% of all projects generating revenues or cost savings, 34.6% and 21.1% of projects generating capital investments and 36.4% and 20.8% of projects having an impact on employment.

3. **Businesses with less than 20 employees and less than $1.0 million in annual revenues were more likely to lead to commercialization and represented over 65% of all industry-sponsored commercialized projects.**

As indicated in Table 4.23, 40.0% of all industry-sponsored projects leading to commercialization were undertaken by organizations with annual revenues of less than $500,000. Organizations with annual revenues ranging between $500,000 and $1.0 million, while accounting for only 18.6% of all funded projects, represented 32.5% of all commercialized projects. By comparison, organizations with annual revenues of $2.0 million or more represented 24.1% of all funded projects but only 17.5% of the projects leading to commercialization.

Similarly, 39.3% of all industry-sponsored projects leading to commercialization were undertaken by organizations with less than 10 employees. Organizations employing between 10 and 19 people, which accounted for 20.0% of all funded projects, represented an additional 23.5% of all commercialized projects. By comparison, organizations with 50 or more employees represented 25.0% of all funded projects but only 15.6% of all projects leading to commercialization.

4. **Over 80% of all commercialized projects involved organizations located in the Lower Mainland.**

Table 4.24

SUMMARY OF ATTRIBUTABLE BENEFITS

	Revenues/Cost Savings											
	To Date ($000)	%	To the Year 2000 ($000)	%	Capital Investment ($000)	%	Jobs Created Maintained	%	Person Years	%	Wages Paid in 1991 ($000)	%
By Type of Proponent:												
Industry	101,343	79.0%	236,510	81.4%	4,998	36.0%	217	70.2%	850	70.4%	7,885	75.9%
University	24,671	19.3	48,927	16.8	1,396	10.1	67	21.7	286	23.6	1,900	18.3
Non-Profit	2,219	1.7	5,141	1.8	7,467	53.9	25	8.1	72	6.0	604	5.8
Total	128,233	100.0	290,578	100.0	13,860	100.0	309	100.0	1,208	100.0	10,389	100.0
By Sector: (1)												
Agriculture & Food (1979)	7,750	6.0%	17,028	5.9%	733	5.3%	24	7.8%	100	8.3%	582	5.6%
Aquatic Resources (1979)	7,372	5.7	17,957	6.2	586	4.2	26	8.4	94	7.8	669	6.4
Biotechnology (1988)	143	0.1	728	0.2	0	-	0	-	0	-	0	-
Computers & Computing (1985)	4,414	3.5	10,553	3.6	24	0.2	27	8.7	83	6.9	997	9.6
Electronics & Communications (1979)	64,340	50.2	128,134	44.1	3,687	26.7	148	47.9	556	46.0	5,591	53.8
Energy (1979)	6,465	5.1	8,489	2.9	414	3.0	8	2.6	37	3.1	247	2.4
Forestry & Forest Products (1979)	4,680	3.6	7,020	2.4	44	0.3	15	4.8	98	8.1	472	4.5
Health Technology (1988)	0	-	0	-	0	-	0	-	0	-	0	-
Manufacturing & Machinery (1979)	29,276	22.8	80,296	27.6	756	5.4	37	12.0	162	13.4	1,093	10.5
Mining, Minerals & Metals (1979)	1,872	1.5	15,933	5.5	166	1.2	3	1.0	12	1.0	180	1.7
Other	1,921	1.5	4,440	1.6	7,449	53.7	21	6.8	65	5.4	560	5.5
Total	128,233	100.0	290,578	100.0	13,860	100.0	309	100.0	1,208	100.0	10,389	100.0
By Location of Proponent:												
Lower Mainland	113,813	88.7%	246,163	84.7%	12,742	91.9%	266	86.1%	1,026	84.9%	9,213	88.7%
Interior	5,518	4.4	5,601	1.9	532	3.8	1	0.3	54	4.5	10	0.1
Vancouver Island	8,902	6.9	38,814	13.4	586	4.3	42	13.6	128	10.6	1,167	11.2
Total	128,233	100.0	290,578	100.0	13,860	100.0	309	100.0	1,208	100.0	10,389	100.0

Sources: Survey of proponents of 96 commercialized projects

Note (1): These results should be taken with relative caution. As indicated, several committees were only created after 1985 and projects funded in these sectors have had comparatively less time to generate economic impacts. Furthermore, a number of projects in various sectors have generated intangible benefits which, while difficult to quantify, probably far exceed the tangible economic impacts shown in this table.

From a regional standpoint, the profile of projects leading to commercialization was very similar to that of all funded projects. As indicated in Table 4.23, organizations located in the Lower Mainland/Southwest Development Region, which represented about 85% of the funding received by all projects, accounted for 80% of all commercialized projects, followed by organizations located in the Vancouver Island/Coast Development Region (16.7%).

Magnitude of Benefits Generated

5. **With the notable exception of capital investments, over 70% of economic benefits to date were generated by industry-sponsored projects.**

Tables 4.24 and 4.25 respectively provide a breakdown of the attributable and incremental benefits generated by the 96 projects leading to commercialization, by type of proponent, economic sector and location. As indicated, industry-sponsored projects generated attributable and incremental revenues and cost savings to date of $101.3 million and $62.7 million respectively, which represents 79.0% and 75.6%, respectively, of the total benefits generated to date. Similarly, industry-sponsored projects generated about 70.0% of the benefits in terms of employment, and 36.0% of capital investments to date. By comparison, university-sponsored projects generated only 19.0% of the revenues and cost savings to date and 22.0% of the benefits in terms of employment.

Interestingly, projects involving non-profit organizations accounted for about 54.0% of the capital investments generated to date. However, as mentioned earlier, this high level of investment was almost entirely the result of the construction of a $25.0 million infrastructure project (Science World B.C.) for which the planning study was funded by the Science Council.

6. **Excluding capital investments, over 60.0% of the economic benefits to date were generated by projects in the electronics/communications and manufacturing/machinery sectors.**

As indicated in Tables 4.24 and 4.25, projects in the electronics/communications sector generated about 50.0% of all revenues and cost savings to date, 27.0% of capital

Table 4.25

SUMMARY OF INCREMENTAL BENEFITS

	Revenues/Cost Savings											
	To Date ($000)	%[1]	To the Year 2000 ($000)	%[1]	Capital Investment ($000)	%[1]	Jobs Created Maintained	%[1]	Person Years	%[1]	Wages Paid in 1991 ($000)	%[1]
By Type of Proponent:												
Industry	62,686	61.8%	159,983	67.6%	2,670	53.4%	161	74.6%	554	65.2%	5,825	73.9%
University	18,553	75.2	34,946	71.4	848	60.7	46	68.7	224	78.3	1,289	67.8
Non-Profit	1,658	74.8	3,873	75.3	5,599	75.0	20	80.0	55	76.4	457	75.7
Total	82,897	64.6	198,802	68.4	9,117	65.8	227	73.5	833	68.9	7,571	72.9
By Sector: (2)												
Agriculture & Food (1979)	6,239	80.5%	12,416	72.9%	495	67.5%	19	79.2%	83	83.0%	496	85.2%
Aquatic Resources (1979)	5,718	77.6	13,626	75.9	447	76.3	20	76.9	69	73.4	514	76.8
Biotechnology (1988)	130	90.9	522	71.7	0	-	0	-	0	-	0	-
Computers & Computing (1985)	3,460	78.4	8,142	77.1	12	50.0	24	88.9	73	87.9	882	88.5
Electronics & Communications (1979)	39,602	61.5	84,827	66.2	1,825	49.5	100	67.6	340	61.1	3,733	66.8
Energy (1979)	4,978	77.0	6,253	73.7	202	48.8	6	75.0	30	81.1	186	75.3
Forestry & Forest Products (1979)	4,301	91.9	6,455	91.9	41	93.2	13	86.7	89	90.8	439	93.0
Health Technology (1988)	0	-	0	-	0	-	0	-	0	-	0	-
Manufacturing & Machinery (1979)	15,561	53.1	48,042	59.8	396	52.4	27	73.0	92	57.4	774	70.8
Mining, Minerals & Metals (1979)	1,467	78.4	15,189	95.3	112	66.9	2	66.7	8	66.7	127	70.5
Other	1,441	75.0	3,330	75.0	5,587	75.0	16	76.2	49	75.4	420	75.0
Total	82,897	64.6	198,802	68.4	9,117	65.8	227	73.5	833	68.9	7,571	72.9
By Location of Proponent:												
Lower Mainland	73,222	64.3%	168,739	68.5%	8,413	66.0%	193	72.6%	709	69.1%	6,622	71.9%
Interior	2,866	51.9	2,923	52.2	279	52.4	0	-	29	53.7	8	80.0
Vancouver Island	6,809	76.5	27,141	69.9	425	72.5	34	80.9	95	74.2	941	80.6
Total	82,897	64.6	198,802	68.4	9,117	65.8	227	73.5	833	68.9	7,571	72.9

Source: Survey of proponents of 96 commercialized projects

Note (1): % of attributable benefits which were incremental

Note (2): These results should be taken with relative caution. As indicated, several committees were only created after 1985 and projects funded in these sectors have had comparatively less time to generate economic impacts. Furthermore, a number of projects in various sectors have generated intangible benefits which, while difficult to quantify, probably far exceed the tangible economic impacts shown in this table.

investments and 48.0% of benefits in terms of employment. Projects in the manufacturing/machinery sector accounted for 23.0% of revenues and cost savings to date, 5.0% of capital investments and 12.0% of employment benefits. By comparison, projects in several sectors such as mining/minerals/metals, biotechnology and health technology generated little or no benefits (less than 2.0% of total benefits). It should be noted, however, that several of these categories were only created in 1988 and that only a small number of associated projects have been funded to date.

7. **Over 80% of all economic benefits to date were generated by projects in the Lower Mainland.**

As indicated in Tables 4.24 and 4.25, projects in the Lower Mainland/Southwest Development Region generated about 89% of revenues and cost savings to date, 92% of capital investments and 86% of benefits in terms of employment. Projects on Vancouver Island accounted for 7% of revenues of cost savings, 4% of capital investments and 14% of benefits in terms of employment.

Incrementality of Benefits Generated

8. **Benefits associated with projects involving non-profit organizations and universities were generally more incremental than those associated with industry-sponsored projects.**

Table 4.25 provides a summary of incremental benefits generated by the 96 commercialized projects, and of the corresponding incrementality factors, by type of proponent, sector and location. For the purposes of this study, we will define the incrementality factor as the ratio of incremental benefits to attributable benefits.

As indicated in Table 4.25, benefits generated by projects involving non-profit organizations tended to be the most incremental, with an incrementality factor ranging from 75% for revenues and cost savings to 80% for the jobs created and maintained. The incrementality of benefits generated by university-sponsored projects varied from 61% (capital investment) to 78% (person years of employment). The incrementality of benefits generated by industry-sponsored projects was comparatively lower, with an incrementality factor ranging from 53% (capital investment) to 75% (jobs created and maintained).

Table 4.26

SUMMARY OF SCIENCE COUNCIL CONTRIBUTIONS (EXPRESSED IN 1991 DOLLARS)

	Projects Responding (300)		**Total Project Population (527)**	
	1991 Value of Funding Received ($000)	**%**	**1991 Value of Funding Received ($000)**	**%**
By Type of Proponent:				
Industry	$ 14,183	48.0%	$ 29,722	48.8%
University	12,948	43.9%	26,213	43.0%
Non-Profit	2,395	8.1%	4,961	8.2%
Total	29,526	100.0%	60,896	100.0%
By Sector:				
Agriculture & Food	$ 2,102	7.1%	$ 4,014	6.6%
Aquatic Resources	2,862	9.7%	9,318	15.3%
Biotechnology	437	1.5%	762	1.2%
Computers & Computing	1,410	4.8%	4,078	6.7%
Electronics & Communications	5,391	18.3%	11,709	19.2%
Energy	3,493	11.8%	5,398	8.9%
Forestry & Forest Products	8,541	28.9%	13,318	21.9%
Health Technology	743	2.5%	753	1.2%
Manufacturing & Machinery	3,271	11.1%	6,447	10.6%
Mining, Minerals & Metals	1,214	4.1%	4,423	7.3%
Other	62	0.2%	676	1.1%
Total	29,526	100.0%	60,896	100.0%
By Location of Proponent:				
Lower Mainland	$ 24,507	83.0%	$ 50,544	83.0%
Interior	561	1.9%	1,157	1.9%
Vancouver Island	4,458	15.1%	9,195	15.1%
Total	29,526	100.0%	60,896	100.0%

Source: Mail Survey of 300 Project Proponents
Science Council data for competitions RC-1 to RC-20 inclusive

As also indicated in Table 4.25, benefits generated by projects in the forestry/forest products, biotechnology and computers/computing sectors and by projects located on Vancouver Island tended to be the most incremental.

Return per Dollar of Science Council Funding

9. **With the exception of capital investment, industry-sponsored projects have generated the greatest return to date in terms of economic impacts per dollar of Science Council funding.**

All STDF and AGAR contributions were restated and adjusted to a common year (1991) using the CPI and are presented in Table 4.26, by type of proponent, economic sector and location. Using the same methodology as in Section C, 2 rates of return were then computed for each category of projects and are presented in Table 4.27. The lower limit represents a worse case scenario and is based on the assumption that our sample of 300 projects captured **all** the projects commercialized to date. The upper limit, on the other hand, assumes that our evaluation did not obtain data on all the projects commercialized to date, and that an equal proportion of benefits was generated by projects not included in our sample of 300. It should also be noted that the returns computed for certain project categories (such as biotechnology) may not be representative due to the small number of funded projects in these categories. As we believe that this evaluation has been successful in capturing data on the economic impacts of the vast majority of the projects which have been commercialized, it is likely that the actual return is much closer to the minimum than to the maximum.

As indicated in Table 4.27, industry-sponsored projects have generally provided a much greater return than have university-sponsored projects or projects involving non-profit organizations. Indeed, industry-sponsored projects have generated, to date, between $2.11 and $4.41 in incremental revenues and cost savings per dollar of funding received, as well as between 1.86 and 3.91 incremental person years of employment per every $100,000 of funding. By comparison, university-sponsored projects have generated only between $0.71 and $1.43 in incremental revenues and cost savings per dollar of funding, and between 0.85 and 1.73 incremental person years of employment per every $100,000 of funding.

Table 4.27

SUMMARY OF RETURNS GENERATED PER DOLLAR OF SCIENCE COUNCIL FUNDING PROVIDED

	INCREMENTAL RETURNS (1)										ATTRIBUTABLE RETURNS (1)									
	Revenues To Date		Revenues To the Year 2000		Capital Investment		Jobs Created		Person Years		Revenues To Date		Revenues To the Year 200		Capital Investment		Jobs Created		Person Years	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
By Type of Proponent:																				
Industry	2.11	4.41	5.38	11.28	0.09	0.19	0.54	1.14	1.86	3.91	3.41	7.14	7.96	16.67	0.17	0.35	0.73	1.53	2.86	5.99
University	0.71	1.43	1.33	2.70	0.03	0.06	0.18	0.36	0.85	1.73	0.94	1.90	1.87	3.78	0.05	0.11	0.26	0.52	1.09	2.21
Non-Profit	0.33	0.69	0.78	1.62	1.13	2.34	0.40	0.83	1.11	2.30	0.45	2.15	1.04	2.15	1.50	3.12	0.50	1.04	1.45	3.01
Total	1.36	2.81	3.26	6.73	0.15	0.31	0.37	0.77	1.37	2.82	2.11	4.34	4.77	9.84	0.23	0.47	0.51	1.05	1.98	4.09
By Sector: (2)																				
Agriculture & Food (1979)	1.55	2.97	3.09	5.91	0.12	0.23	0.47	0.90	2.07	3.95	1.93	3.69	4.24	8.10	0.18	0.35	0.60	1.14	2.49	4.76
Aquatic Resources (1979)	0.61	2.00	1.46	4.76	0.05	0.16	0.21	0.70	0.74	2.41	0.79	2.58	1.93	6.27	0.06	0.20	0.28	0.91	1.01	3.28
Biotechnology (1988)	0.17	0.30	0.68	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.33	0.96	1.67	0.00	0.00	0.00	0.00	0.00	0.00
Computers & Computing (1985)	0.85	2.45	2.00	5.77	0.00	0.01	0.59	1.70	1.79	5.18	1.08	3.13	2.59	7.48	0.00	0.02	0.66	1.91	2.03	5.89
Electronics & Communications (1979)	3.38	7.34	7.24	15.73	0.16	0.34	0.85	1.85	2.90	6.31	5.49	11.93	10.94	23.77	0.31	0.68	1.26	2.74	4.75	10.31
Energy (1979)	0.92	1.42	1.16	1.79	0.04	0.06	0.11	0.17	0.56	0.86	1.20	1.85	1.57	2.43	0.08	0.12	0.15	0.23	0.68	1.06
Forestry & Forest Products (1979)	0.32	0.50	0.48	0.76	0.00	0.00	0.10	0.15	0.67	1.04	0.35	0.55	0.53	0.82	0.00	0.01	0.11	0.18	0.74	1.15
Health Technology (1988)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manufacturing & Machinery (1979)	2.41	4.76	7.45	14.69	0.06	0.12	0.42	0.83	1.43	2.81	4.54	8.95	12.45	24.55	0.12	0.23	0.57	1.13	2.51	4.95
Mining, Minerals & Metals (1979)	0.33	1.21	3.43	12.51	0.03	0.09	0.05	0.16	0.18	0.66	0.42	1.54	3.60	13.12	0.04	0.14	0.07	0.25	0.27	0.99
Other	2.13	23.24	4.93	53.71	8.26	90.11	2.37	25.81	7.25	79.03	2.84	32.02	6.57	71.61	11.02	120.14	3.11	33.87	9.61	104.84
Total	1.36	2.81	3.26	6.73	0.15	0.31	0.37	0.77	1.37	2.82	2.11	4.34	4.77	9.84	0.23	0.47	0.51	1.05	1.98	4.09
By Location of Proponent:																				
Lower Mainland	1.45	2.99	3.34	6.89	0.17	0.34	0.38	0.79	1.40	2.89	2.25	4.64	4.87	10.04	0.25	0.52	0.53	1.08	2.03	4.19
Interior	2.48	5.11	2.53	5.21	0.24	0.50	0.00	0.00	2.51	5.17	4.77	9.84	4.84	9.98	0.46	0.95	0.09	0.18	4.67	9.63
Vancouver Island	0.74	1.53	2.95	6.09	0.05	0.09	0.37	0.76	1.03	2.13	0.97	2.00	4.22	8.71	0.06	0.13	0.46	0.94	1.39	2.87
Total	1.36	2.81	3.26	6.73	0.15	0.31	0.37	0.77	1.37	2.82	2.11	4.34	4.77	9.84	0.23	0.47	0.51	1.05	1.98	4.09

Source: Survey of proponents of 96 commercialized projects

Note (1): All returns are expressed as dollars generated per every dollar of funding provided, except for employment, where returns are expressed as number of jobs or person years of employment per every $100,000 of funding provided.

Note (2): These results should be taken with relative caution. As indicated, several committees were only created after 1985 and projects funded in these sectors have had comparatively less time to generate economic impacts. Furthermore, a number of projects in various sectors have generated intangible benefits which, while difficult to quantify, probably far exceed the tangible economic impacts shown in this table.

Projects involving non-profit organizations have provided the greatest return in terms of capital investment (between $1.13 and $2.34 per dollar of funding). However, as mentioned earlier, this above-average level of return was largely the result of the construction of a major infrastructure project for which the planning study was funded by the Science Council.

10. **Projects in the electronics/communication and agriculture/food sectors generally achieved the greatest economic returns per dollar of Science Council funding.**

As noted earlier, the results tabulated by economic sector should be taken with relative caution since several committees were only created after 1985 and projects in these sectors have had comparatively less time to generate economic impacts. Furthermore, a number of projects in various sectors have generated intangible benefits which, while difficult to quantify, probably far exceed their tangible economic impacts.

With these considerations in mind, and as indicated in Table 4.27, projects in the electronics and communications sector appear to have provided the greatest returns in terms of incremental revenues and cost savings to date (between $3.38 and $7.34 per dollar of funding), capital investment ($0.16 to $0.34) and person years of employment (between 2.90 and 6.31 person years per $100,000 of funding). Projects in the agriculture and food sector, while only providing the third highest return in terms of revenues and cost savings to date ($1.55 to $2.97), achieved the second highest return in terms of capital investment ($0.12 to $0.23) and person years of employment (2.07 to 3.95). Projects in the manufacturing and machinery sector achieved the second highest return in terms of revenues and cost savings to date ($2.41 to $4.76) but only the fourth highest return in terms of person years of employment (1.43 to 2.81) and capital investment ($0.06 to $0.12).

11. **Although the average return has been greatest for projects located in the interior, it should be remembered that these returns are based on the results of only 3 projects.**

As indicated in Table 4.27, the average returns achieved by projects in the Lower Mainland have been greater than the average return generated by projects on Vancouver island.

Major Constraints to Commercialization

12. The need for further research was the major constraint to commercialization for projects not yet commercialized.

Of the 300 respondents to our mail questionnaire, those indicating that the results of their project had not been commercialized were surveyed to identify the key factors which had constrained commercialization. Seventy-six of the 160 respondents to this question (47.5%) indicated that the major factor constraining commercialization was the need for further research before the results of the project could be commercialized, often because of unforeseen technical problems. This finding is not really surprising insofar as 50 of the 96 projects eventually commercialized (52.1%) also required, according to their proponent, additional research and development before they were ready for commercialization. Other factors identified by proponents as constraints to commercialization included:

- The funding necessary for commercialization was not available (17% of respondents);
- The organization did not have the technical or business capabilities required to directly implement the results (16% of respondents);
- A market, sufficient to warrant commercialization, was not identified (14% of respondents);
- The research proved that commercialization was not feasible (8% of respondents).

V. PROGRAM DELIVERY

This chapter summarizes our findings with respect to the delivery of STDF/AGAR. Two evaluation issues were established with represent to program delivery including:

Issue 3.1: **Were the programs and the assisted projects implemented in a manner conducive to the realization of their objectives and intended impacts and effects?**

Issue 3.2: **Are there more effective ways to achieve the intended impacts and effects of STDF-AGAR?**

In order to obtain feedback with respect to these issues, we conducted a survey of 219 proponents who had received funding under AGAR or STDF, 5 representatives of the Science Council, 87 representatives of the Peer Review Committees, 50 proponents of applications which were rejected or withdrawn, and 19 representatives who may have been eligible for funding but did not apply to the Science Council. The major findings of the evaluation with respect to promotion of the program, the level of proponent satisfaction with the Science Council programs, and the program funding guidelines and structure are summarized in the following sections.

CHAPTER HIGHLIGHTS

The major findings of the evaluation as they relate to program delivery are summarized as follows:

- Awareness of Technology B.C. appears to be relatively high, particularly amongst research organizations located in the Lower Mainland and in Victoria. However, many of the respondents surveyed recommended that a greater emphasis be placed on increasing awareness of the program amongst small and medium-sized businesses and amongst organizations located outside of the Lower Mainland and Victoria.

- The majority of proponents rated program features such as the availability of information on the program, suitability of the eligibility requirements, clarity of the program guidelines, availability of advice upon applying to the program, and length

of time between project approval and receipt of funds as satisfactory or better. There was some concern expressed with respect to the reporting requirements (particularly amongst proponents associated with universities and colleges) and the length of time required for approval (particularly amongst private sector proponents), although the majority of proponents who expressed an opinion still found these features to be satisfactory. We found very few instances where the economic impacts generated by a project were constrained by program features such as the reporting requirements or the length of time required for approval.

- The majority of the Peer Review Committee members surveyed indicated that the eligibility criteria and funding guidelines established for the Technology B.C. programs are appropriate. However, there was support for increasing flexibility with respect to the allocation of funding between core research and industry based research, the definition of eligible project costs, and the proportion of total project costs for industry based research that must be funded by the proponent. In addition, it was recommended that the Science Council provide greater assistance to small and medium sized businesses in preparing proposals for funding.

- The Peer Review Committee members surveyed were generally not in favour of establishing a mechanism to encourage the awarding of larger grants. Many expressed the opinion that funding a large number of small projects was likely more effective in terms of promoting economic development and diversification than funding a few large projects.

- The Science Council represents a very cost-effective mechanism for delivering the Technology B.C. program. The cost of administration expressed as a percent of the value of grants awarded declined from 5.8% in 1986-87 to 4.6% in 1990-91.

A. PROMOTION OF THE PROGRAM

The major findings of the evaluation with respect to promotion of the applied research and development programs are as follows:

Table 5.1

SOURCE OF AWARENESS FOR AGAR AND STDF

Question: How did you first become aware of Science Council funding programs for applied research and development?

Response	Past Proponents	Proponents of Rejected and Withdrawn Applicants	Non Applicants
Referred by another member of their organization	28.8%	56.0%	0.0%
Read an advertisement or brochure	24.2	8.0	15.4
Through contact with representatives of the Science Council	13.7	10.0	38.5
Referred by a past funding recipient	11.0	10.0	0.0
Through contact with a representative of the Ministry of Advanced Education, Training and Technology	2.3	0.0	0.0
An article in the news media	1.8	0.0	15.4
Other	9.1	0.0	0.0
Don't Remember	9.1	16.0	30.7
	100.0%	100.0%	100.0%
Number of Respondents	219	50	13

1. **Word-of-mouth and advertisements and brochures are the leading means through which proponents first became aware of the AGAR and STDF programs.**

As indicated in Table 5.1, 28.8% of the 219 respondents to the general questionnaire first became aware of the programs through referrals from other members of their organizations while 24.2% first became aware by reading an advertisement or brochure on the program. Of the 50 proponents of rejected and withdrawn applications we surveyed, 28 (56%) first became aware of the Science Council programs through referrals from other members of their organizations. Of these 50 proponents, 30 (60%) were aware that STDF-AGAR had been renamed Technology B.C.

The AGAR program was not heavily promoted, relying primarily upon word-of-mouth and referrals from other agencies as well as encouraging news stories in the media regarding the more successful and interesting projects. However, introduction of the STDF competition was supported by a significant promotional program undertaken by the Ministry of Advanced Education and Job Training. As a result, the proponents we surveyed who first applied to the Science Council for applied research and development funding in 1988 were more than twice as likely to have become aware of the program through an advertisement or brochure than were proponents who first applied prior to 1988.

Since the amalgamation of the two programs, STDF-AGAR (Technology B.C.) has continued to be promoted aggressively. For example, in 1990-91, the promotional budget for the program totalled $60,000 as compared to the budget of $5,000 established to support the AGAR program in 1986-87. In addition to continuing to encourage news stories, promotional vehicles have include newspaper advertisements placed throughout the province before each competition, advertisements in selected trade journals and B.C.-based magazines, promotional news releases and brochures, public speaking engagements at industry association meetings and conventions, and referrals through SPARK. The survey results suggest that brochures, advertisements, and public speaking engagements at industry association meetings and conventions are the key component of the promotional program for private sector representatives. The leading sources of awareness for private sector proponents surveyed were advertisements, brochures and contacts with a representative of the Science Council while the leading source of awareness for proponents associated with universities, colleges and not-for-profit organizations was a referral from another member of their organization.

2. **Over 70% of the proponents surveyed, who expressed an opinion, were "satisfied" or "extremely satisfied" with the promotion of the Science Council programs to their industry or sector.**

Of the 219 respondents surveyed, 126 stated that they were "satisfied" or "extremely satisfied" with the promotion of the Science Council programs to their industry or sector while 42 did not express an opinion as indicated below:

LEVEL OF PROPONENT SATISFACTION WITH PROMOTIONAL PROGRAM

Question: **Based upon your experience with the Science Council programs, please rate how satisfied you are with the promotion of the program to your industry sector?**

Response	**Number**	**Percent**
Not at all satisfied	2	0.9%
Not very satisfied	11	5.0
Moderately satisfied	38	17.4
Satisfied	102	46.6
Extremely satisfied	24	11.0
No opinion	42	19.1
Total	219	100.0%

Satisfaction with the promotional program did not vary significantly by type of proponent, year that the proponent first received funding from the Science Council, or sector.

3. **Of the Peer Review Committee members responding to our survey, approximately 60% believe that the STDF-AGAR and Technology B.C. programs have been well promoted (in terms of generating a high level of awareness amongst the target groups).**

As indicated below, 52 of the 87 respondents to the Peer Review Committee questionnaire felt that the programs have been well promoted while 14 did not express an opinion.

SATISFACTION WITH PROMOTIONAL PROGRAM AMONGST PEER REVIEW COMMITTEE MEMBERS

Question: In your opinion, have the STDF-AGAR and Technology B.C. programs been well promoted (Is there a high level of awareness regarding these programs amongst the target group)?

Response	Number	Percent
Yes	52	59.8%
No	21	24.1
Don't Know/No Response	14	16.1
Total	87	100.0%

However, almost one-quarter (24.1%) of the committee members felt that the program is not well promoted.

4. **While the level of satisfaction is reasonably high amongst proponents and Peer Review Committee members, there may be opportunities to improve the effectiveness of the promotional program.**

An extensive survey to determine the level of industry awareness of the Technology B.C. program was beyond the scope of this evaluation. However, a surrogate measure is the level of awareness amongst the 19 non-applicants who were surveyed. Of the 19 non-applicants surveyed, all of whom are drawn from the private sector, 13 were aware of one or more of the Science Council programs which have provided funding for applied research and development. Of these 13 respondents, 12 were aware of the AGAR and STDF programs, 8 were aware of STDF-AGAR, and 7 were aware of Technology B.C. As indicated in Table 5.1, the leading source of awareness for non-applicants was contact with representatives of the Science Council.

A lack of awareness of the Science Council programs at the time the project was undertaken was cited by 7 (37%) of the non-applicants as the reason for not applying. Other reasons cited for not applying to the Science Council for funding included: another program was better suited to their needs (3 respondents); the turnaround time on applications to the Science Council is too lengthy (3 respondents); and the non-applicant perceived the chances of successfully obtaining Science Council funding to be low (2 respondents). Funding for these projects was obtained from Western Economic Diversification, NRC IRAP, NSERC, ISTC, and ARDSA as well as from private sources.

Representatives from the Peer Review Committees provided a number of recommendations designed to improve the effectiveness of the promotional program. These included:

- Eleven of the Peer Review Committee representatives recommended that a greater emphasis should be placed upon increasing awareness amongst firms in the private sector, particularly amongst small and medium sized businesses. Given that awareness amongst potential applicants from not-for profit organizations and universities and colleges can adequately be generated through word-of-mouth (particularly referrals from other members of the same organization), several representatives noted that the primary focus of the formal promotional program should be on increasing awareness of the Technology B.C. program in the private sector.

- The Science Council should make greater use of seminars, workshops and other face-to-face mediums to promote Technology B.C. (4 respondents). These seminars and workshops should be targeted not only at potential applicants, but also at potential intermediaries and referral sources such as regional economic development officers, industry associations, community colleges, and NRC Industrial Technology Advisors.

- A greater emphasis should be made to create awareness and encourage applications from firms located outside of the Lower Mainland and Victoria (4 respondents). As discussed in Chapter IV, 85% of program funding has been awarded to organizations in the Lower Mainland and 14% has been awarded to organizations in the Lower Mainland or on Vancouver Island.

- The Science Council has prepared a formal communication plan in the past which outlines the communication activities that will be undertaken. It has been recommended that the Science Council should go beyond this and create a formal marketing plan which clearly identifies the target market, the objectives of the promotional plan, and the vehicles that will be used (3 respondents). It would also be useful to establish a system to evaluate the effectiveness of the promotional program. For example, a database could be constructed to monitor the number of applications received by region and the number of applications received from applicants who have never applied to the Science Council for applied research and development funding in the past. In addition, a random survey could be conducted to estimate the level of awareness amongst industry representatives.

Several Peer Review Committee representatives recommended that the level of promotion should not be increased because the approval rate for applications is already low and, in their opinion, most of the organizations active in applied research and development are already aware of the program. However, it should be noted that the role of the AGAR and STDF programs has generally been to facilitate rather than to stimulate applied research and development projects; the decision to undertake a specific research and development project is made first and then, after reviewing potential sources of funding, the applicant may decide to submit a proposal to the Science Council. It is generally not the availability of funding that stimulates the applicant to look for a research and development project. For example, 48 of the 50 proponents of applications which were rejected by Science Council had been planning their projects prior to hearing about the Science Council program.

B. PROPONENT SATISFACTION WITH THE PROGRAM FEATURES

The major findings of our evaluation regarding the level of proponent satisfaction with the features of the Science Council applied research and development funding programs are as follows:

1. **The vast majority of proponents were satisfied with the program or programs under which they received funding from the Science Council.**

   One indicator of the effectiveness of any government program is the level of satisfaction amongst the client group, as defined by the proponents who have received assistance. Of the 219 respondents surveyed, 168 stated that they were "satisfied" or "extremely satisfied" with the program(s) under which they received funding from the Science Council as indicated below:

LEVEL OF PROPONENT SATISFACTION WITH THE FUNDING PROGRAM

Question: How satisfied are you with the program(s) under which you received funding from the Science Council?

Response	Number	Percent
Not at all satisfied	1	0.5%
Not very satisfied	3	1.4
Moderately satisfied	29	13.2
Satisfied	102	46.6
Extremely satisfied	65	29.7
No opinion	19	8.7
Total	219	100.0%

Excluding the 19 respondents who did not express an opinion, almost 85% of the respondents were "satisfied" or "extremely satisfied" with the funding program. Of the 4 proponents who indicated that they were "not at all satisfied" or "not very satisfied" with the program or programs, two were dissatisfied with the eligibility requirements (one respondent was disappointed that his application for project renewal was not approved and one felt that too much emphasis was placed on short-term economic impacts) and two were dissatisfied about program delivery issues (one respondent felt that the turnaround time on applications was too slow and one believed that too much reporting is required during the course of the project).

The level of satisfaction with the programs did not vary significantly by type of proponent or year of funding, although the average level of satisfaction tended to be slightly higher among industry representatives than among proponents from universities and colleges and slightly higher among proponents who received their first award from the Science Council in 1987, 1988, or 1989.

2. **The proponents were generally satisfied with the application and approval process, but expressed some concern regarding the reporting requirements and the length of time required for approval.**

The proponents were asked to rate their level of satisfaction with various features of the AGAR and STDF programs. As indicated in Table 5.2, the majority of proponents rated

Table 5.2

PROPONENTS RATING OF PROGRAM FEATURES

Question: Based on your experience with the Science Council programs, please rate how satisfied you are with each of the following features:

	Level of Satisfaction (% of Respondents)						
	Not At All	Not Very	Moderately	Satisfied	Extremely	No Opinion	Total
Availability of information on the program(s)	0.5%	3.2	9.6	52.5	24.2	10.0	100.0%
Suitability of the eligibility requirements	1.4%	7.3	13.6	52.1	14.6	11.0	100.0
Clarity of the program guidelines	0.9%	4.6	15.1	51.1	18.7	9.6	100.0
Availability of advice on applying to the program(s)	1.4%	5.0	11.9	42.9	24.7	14.2	100.0
Length of time between your application and funding approval	3.2%	12.8	24.2	42.5	7.3	10.0	100.0
Length of time between approval and receipt of funds	0.5%	3.2	12.8	48.4	25.1	10.0	100.0
Requirements with respect to reporting programs or projects	3.7%	11.4	19.2	44.3	12.3	9.1	100.0

Based on responses of 219 proponents who received funding under AGAR or STDF.

features such as the availability of information on the program, suitability of the eligibility requirements, clarity of the program guidelines, availability of advice upon applying to the program, and length of time between project approval and receipt of funds as satisfactory or better. In particular, the awards officers were praised for being of assistance during the application process as well as during implementation of the project.

There was some concern expressed with respect to the reporting requirements and the length of time required for approval, although the majority of proponents who expressed an opinion still found these features to be satisfactory. As indicated in Table 5.2, 16% of the proponents found the length of time between submission of the application and approval to be "not at all" or "not very" satisfactory. Eleven of the proponents noted that the length of time required for approval made it very difficult to plan research and development activities, particularly for private sector firms. In addition, 15.1% of the proponents found the requirements with respect to reporting progress on the project be "not at all" or "not very satisfactory". Twenty-seven of the proponents (primarily proponents associated with universities and colleges) stated that the requirement for quarterly reports was excessive; approximately one-half of these respondents recommended that reports should be filed only once per year while others recommended that reports should be submitted every six or every four months.

Satisfaction with the various features of the AGAR and STDF programs varied by type of proponent as described below:

- Dissatisfaction regarding the length of time required for project approval is greatest amongst private sector proponents. Only 39% of the private sector proponents found the length of time between submission of the application and project approval to be "satisfactory" or "extremely satisfactory" as compared to over 60% of proponents from universities and colleges.

- Dissatisfaction regarding reporting requirements is greatest amongst proponents from universities and colleges. Almost three-quarters (74%) of the private sector proponents found the requirements with respect to reporting on the progress of the projects to be "satisfactory" or "extremely satisfactory" as compared to only 39% of proponents from universities and colleges.

- Proponents from the private sector tended to express greater satisfaction with the eligibility requirements than did proponents associated with universities and colleges. In addition, proponents who have only received funding from the Science Council during the past three years tended to be more satisfied with the eligibility requirements (for example, 80% ranked the eligibility requirements as "satisfactory" or "extremely satisfactory") than were proponents who had received their first award from Science Council prior to 1987 (55% ranked the eligibility requirements as "satisfactory" or "extremely satisfactory"). These findings reflect the dissatisfaction, existing amongst some proponents from universities and colleges who had received funding under AGAR, regarding the changes in eligibility requirements which occurred when the AGAR and STDF programs were amalgamated. These proponents felt that the new guidelines restricted their access to funding and also placed too great of an emphasis on short-term economic impacts.

3. The program features generally did not impair the effectiveness of research projects.

The reaction of the Science Council to the concerns expressed by proponents should be a function not only of the level of dissatisfaction with any of the program features but also the extent to which these program features served to impair the effectiveness of the research projects. For example, do the concerns expressed by the respondents only represent an inconvenience or a minor problem for the proponent or, conversely, have they served to constrain the economic impacts and effects generated by the projects to the extent that certain program features are, in essence, working at cross-purposes to the intentions of the program.

Only 30 of the proponents surveyed (13.7%) felt that any of the program features had impaired the effectiveness of their research efforts on any project for which they received funding from the Science Council. Even among these 30 projects, it is unlikely that there were more than 4 or 5 projects where the potential economic impacts and effects of the projects were significantly constrained. The specific features which were identified by the proponents as impairing the effectiveness of their projects included:

- The extensive reporting requirements took away from the time available to the proponent to undertake the research project (9 respondents);
- The long turn-around time associated with the applications made it much more difficult to plan the research and development project (7 respondents);
- Implementation of multi-year projects is impaired by the requirement to reapply for funding each year (4 respondents);
- The terms of the funding award are not very flexible, which makes it difficult to react to unexpected research results or to unforseen delays in implementation (3 respondents);
- Delays in receiving payment required the proponent to spend a considerable amount of time arranging bridge financing (2 respondents);
- The focus on generating economic impacts in the short-term caused the project to be restructured in such a way that it will likely have less of an impact over the longer-term than it otherwise would have had (2 respondents);
- Given the limited resources available to the firm, the requirement that the private sector company provided funding of at least 50% meant that the project had to be scaled-down considerably (1 respondent).

Proponents from universities and colleges and proponents who had first received funding from the Science Council prior to 1987 were slightly more likely to respond that one or more features of the program had impaired the effectiveness of their research project than were other proponents.

C. FUNDING GUIDELINES AND STRUCTURE OF THE PROGRAM

The major findings of the evaluation with respect to the funding guidelines and the structure of the program are as follows:

1. **There was strong support amongst the Peer Review Committee members for the eligibility criteria established for the Technology B.C. program.**

   The opinions of the Peer Review Committee members regarding the funding guidelines and structure of the program are valid and very useful because the members are very familiar with the objectives and structure of the program, are drawn from government, industry and research organizations, and represent a range of industry sectors.

   Almost two-thirds (65.5%) of the committee members surveyed believed that the project selection criteria were very appropriate given the objectives of the program. In particular, many respondents felt that there an appropriate balance had been struck between the technical merits of a proposal and the potential economic benefits that could be generated through commercialization of the proposed product or process.

   However, several recommendations were received regarding how the eligibility criteria could be enhanced including:

   - Four respondents recommended that core research projects be approved only where there is evidence of close collaboration between the researcher and industry representatives who would be actively involved in commercialization of the resulting product or process.

   - Three respondents recommended that a greater emphasis should be placed upon the potential market and the ability of the proponent to commercialize the resulting product or process.

   - Two respondents argued that the three year to five year horizon for commercialization could be relaxed where warranted by the magnitude of the potential benefits over the longer-term.

Table 5.3

LEADING REASONS FOR REJECTION OF APPLICATION

(Number of Applications Rejected)

Leading Reason for Rejection	Number of Rejections	Percent
The project is unlikely to generate significant economic benefits for B.C.	31	24.4%
The proposal is incomplete technically (lack of technical information).	18	14.2
The research area is a low priority for funding.	10	7.9
The project is beyond the research stage.	10	7.9
The proponent does not have the requisite experience or expertise to undertake the project.	9	7.1
The technology is already available.	8	6.3
The process of commercialization will be too expensive or will take to long to complete.	7	5.5
The proposal is outside the scope of the program.	6	4.7
The research is to fundamental in nature.	6	4.7
The proposal was poorly prepared.	6	4.7
No funding is available (rejected from "B" list).	5	3.9
The project has already been funded.	3	2.4
The cost of the project is unreasonably high.	2	1.6
Other	6	4.7
	127	100.0%

2. **In recent competitions, the leading reasons why applications have been rejected were that the proposed project was unlikely to generate significant economic benefits in B.C. or that the proposal was incomplete technically.**

A 127 review of applications to the STDF-AGAR program (competitions SA-1, SA-2, and SA-3) which were rejected was undertaken to identify the leading reasons for rejection. As indicated in Table 5.3, the two leading reasons for rejection, as quoted by the Science Council in letters to applicants notifying them that their applications had been rejected, were that the project is unlikely to generate significant economic benefits in B.C. (24.4% of rejections) and the proposal is incomplete technically (14.2%). The reasons for rejection did not vary significantly between applications for core research and applications for industry based research in that these two reasons were also the leading reasons for rejection for both sub-programs. However, with respect to the other reasons, applications for core research were much more likely to be rejected on the basis of no funding available, the proponent does not have the requisite experience or expertise, or the technology is already available than were applications to the industry based research sub-program. Conversely, applications for industry based research were much more likely to be rejected on the basis that the research area is a low priority for funding or the project is too fundamental in nature than were applications to the core research sub-program.

Of the rejected applications reviewed, 28 were rejected at the first Peer Review Committee meeting, 41 were rejected at the second Peer Review Committee meeting, and 5 were rejected at the Science and Technology Grants Committee meeting. From the file review, we could not discern at what point in the review process the other applications were rejected.

Concern was expressed by a number of Peer Review Committee members that potentially very useful research projects were not being funded because the proponents are not capable of preparing an adequate proposal. Such proponents could be dissuaded from applying to the program by the need to prepare a detailed proposal or be rejected because the quality of proposal was poor or it was incomplete technically. To ease this constraint, it was recommended that the Science Council conduct seminars and workshops to assist potential applicants in preparing applications, provide direct assistance in some situations, and

Table 5.4

PERCEPTIONS OF PEER REVIEW COMMITTEE MEMBERS REGARDING APPROPRIATENESS OF FUNDING GUIDELINES

Question: Keeping in mind that the purpose of the program is to promote economic development, how appropriate do you believe the following funding guidelines are?

Funding Guideline	Not Very Appropriate	Somewhat Appropriate	Very Appropriate	No Opinion	Total
The project selection criteria established for the program	3.4%	28.7	65.5	2.4	100.0%
Allocation of funding between the Core Research and Industry Based Research Programs	24.1%	37.9	27.6	10.4	100.0%
Proportion of total project costs eligible for funding under the Industry Based Research Program	11.5%	29.8	43.7	15.0	100.0%
Definition of eligible costs	8.0%	19.5	64.4	8.1	100.0%
Allocation of funding between new versus renewal projects	9.2%	29.9	50.6	10.3	100.0%
The system used to allocate funding between review committees	8.0%	27.6	37.9	26.4	100.0%
Length of time for which a project can receive funding	14.9%	27.6	51.7	5.8	100.0%

Source: Survey of 87 Peer Review Committee Members establish a referral service through which potential applicants could be referred to consultants who could be of assistance in the preparation of proposals.

3. **The majority of the Peer Review Committee members surveyed indicated that the funding guidelines established for the Technology B.C. program are appropriate.**

The Peer Review Committee members were asked to rate the appropriateness of various funding guidelines established for the Technology B.C. program. The results are shown in Table 5.4 and briefly discussed below:

- A variety of opinions were expressed by the committee members regarding the appropriateness of allocating 70% of the funding to industry based research and 30% to core based research. As indicated in Table 5.3, almost one-quarter (24.1%) of the committee members felt that this allocation was not very appropriate. However, even this group was divided in terms of its opinions; for example, 4 of the committee members felt that the proportion allocated to core research should be increased, 8 committee members felt that the proportion allocated to core funding should be decreased, and 5 felt that the allocation should vary from year to year depending upon the demand for funding and the quality of the proposals received.

- The Peer Review Committee members were generally supportive of the guideline which requires private sector companies to fund at least 50% of the total project costs. However, several committee members suggested that in special situations, where the potential benefits are significant but the proponent does not have the necessary resources to undertake the project without additional financial assistance, the Peer Review Committee should have the option of recommending funding of more than 50% of the project costs.

- The majority of the Peer Review Committee members surveyed believe that the definition of eligible costs is very appropriate. However, several committee members recommended that guidelines regarding overhead costs and the purchase of equipment be eased. In addition, funding could be provided to assist proponents in marketing or disseminating the results of the research thereby assisting them in taking the next step towards commercialization.

- The majority of the Peer Review Committee members surveyed believe that it is very appropriate to limit funding for renewals project to 40% of approved funding. Although no changes were recommended, several committee members noted that renewals were almost automatic unless the project had made very poor progress.

- No major concerns were expressed with respect to the system used to allocate funding between Peer Review Committees. While the potential may exist to generate greater economic impacts by focusing resources on a smaller number of potential high-growth sectors, such an approach also carries significantly higher-risks and would likely be politically unacceptable.

- The majority of the Peer Review Committee members surveyed indicated that it is "very appropriate" to limit the length of project funding to three years. Of the members who indicated that is was "not very appropriate", 3 said that funding should be limited to two years or less while 7 indicated that funding of more than three years should be permitted in special circumstances.

4. **The Peer Review Committee members surveyed were generally not in favour of establishing a mechanism to encourage the awarding of larger grants.**

Although there is no formal maximum award per project, the desire of Peer Review Committees to spread available funding among numerous projects has, in effect, introduced a limit. The Peer Review Committee members were asked whether, in their opinion, the limited number of large grants awarded had detracted from the overall effectiveness of the program. As indicated below, only 19 of the committee members believed that the effectiveness of the programs had been reduced.

IMPACT OF LIMITED NUMBER OF LARGE GRANTS
ON EFFECTIVENESS OF PROGRAM

Question: Although there is no upper funding per project, very few large grants (for example, over $200,000) have been awarded under the programs. Do you believe that this may have detracted from the effectiveness of the program?

Response	Number	Percent
Yes	19	21.8%
No	54	62.1
Don't Know/No Response	14	16.1
Total	87	100.0%

In order to increase the number of large grants awarded, 11 respondents recommended that a new program or sub-program be established which focuses solely on grants of $200,000 or greater. However, the majority of respondents were satisfied with the existing structure and many expressed the opinion that funding a large number of small projects was likely more effective in terms of promoting economic development and diversification than funding a few large projects.

5. **The majority of the Peer Review Committee members consider the current process of evaluating applications and selecting projects to be "effective" or "extremely effective".**

As indicated below, only 4 of the Peer Review Committee members surveyed found the existing system to be "not at all effective" or not very effective".

PERCEPTIONS REGARDING EFFECTIVENESS OF PROCESS TO EVALUATE APPLICATIONS AND SELECT PROJECTS

Question: In your opinion, how effective is the current process of evaluating applications and selecting projects for funding?

Response	Number	Percent
Not at all effective	1	1.1%
Not very effective	3	3.4
Moderately effective	15	17.2
Effective	58	66.7
Extremely effective	6	6.9
No opinion	4	4.7
Total	87	100.0%

However, a variety of recommendations were received regarding ways in which the evaluation and selection process could be improved. These included:

- In the application, a greater emphasis should be placed on identifying the potential market, competition and commercial risks associated with the proposed product or process and a lesser emphasis be placed on obtaining a detailed technical description of the research project. In addition, a description of the specific steps that would be undertaken in moving the product or process from the research stage to commercialization should be provided.

- Several respondents noted that the external reviews focused primarily upon the technical merits of the applications and that it would be useful to obtain input from at least one external reviewer who is in a position to comment on the market potential of the proposed product or process and the prospects for commercialization.

- The application form should be revised and streamlined. It was noted by several Peer Review Committee members that the application form appeared to be targeted at researchers from universities and colleges or from large research organizations and, therefore, may serve to discourage applicants from small and medium sized private sector organizations. As noted above,

Table 5.5

SUMMARY OF ADMINISTRATION COSTS FOR APPLIED RESEARCH AND DEVELOPMENT FUNDING PROGRAMS ADMINISTERED BY SCIENCE COUNCIL

Expenses	Fiscal Year 1986-1987	Fiscal Year 1990-1991
Staff salaries and benefits[1]	$105,000	$250,000
General overhead[2]	50,000	125,000
Evaluation expenses (honoraria, volunteer travel expenses)	10,000	50,000
Promotion and publicity	5,000	60,000
Total	$170,000	$485,000

Source: Science Council

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[1] Includes benefits estimated at 16% of salaries.

[2] Portion of SCBC general overhead attributable to program activities.

several committee members also recommended that a greater emphasis be placed upon obtaining a description of the market prospects for the proposed product or process and the proposed commercialization process. It was noted that the proposals usually do not contain a sufficient discussion of the applicability of the technology to industry, the size of the potential market and the competitive situation to enable the Peer Review Committee members to assess the reasonability of the estimates of potential revenues, costs savings and employment contained in the application.

- Two committee members recommended that a short list of applications be developed for each competition and the listed applicants be invited to make a short (15 minute to 20 minute) presentation of their application.

6. The Science Council represents a very cost-effective mechanism for delivering the Technology B.C. program.

The Science Council has been responsible for promoting, administering, and monitoring the applied research and development funding programs. Administration and monitoring is facilitated through the awards group which consists of an Awards Manager and three Awards Officers. This group was expanded two years ago in light of the increased grant funding and the accompanying administrative and monitoring requirements. The costs associated with reviewing and priorizing applications is minimized through the heavy reliance upon Peer Review Committees. Membership in these committees consists of volunteers; the only expenses associated with the committee system relate to the reimbursement of travel expenses. Honoraria may be paid to individuals conducting an external review of applications.

At our request, the Science Council prepared an estimate of the administration costs for the program for the 1990-91 fiscal year and, for comparison purposes, the 1986-87 fiscal year. As indicated in Table 5.5, the administrative costs have increased from approximately $170,000 in 1986-87 to $485,000 in 1990-91. The number of staff assigned to program administration increased from two to six.

Table 5.6

SUMMARY OF MAJOR RECOMMENDATIONS BY TYPE OF RESPONDENT

Recommendation	Peer Review Committee Members	Proponents	Rejected/ Withdrawn	Non-Applicants
1. Program Promotion:				
• Expand promotional activities to create greater awareness of program and benefits	1	3	1	0
• Focus promotional effort more directly on potential private sector applicants	1	2	0	0
• Greater emphasis should be placed on creating awareness outside of Victoria and Lower Mainland and amongst smaller and medium-sized businesses	14	3	0	0
• Establish a formal marketing plan	3	0	0	0
2. Application and Review Process				
• The application should be streamlined and made more "user-friendly" for applicants from non-research organizations	3	0	1	2
• The review and approval process should be streamlined and shortened where possible	5	11	1	1
• More competitions should be staged each year to speed up the process	0	1	2	0
• Unsuccessful applicants should receive a better explanation as to why the proposal was rejected	1	4	2	0
• The Peer Review Committee system should be strengthened	0	5	6	
• The appeal system should be improved	2	1	2	0
• Assistance should be provided in the preparation of applications (through workshops, seminars, direct assistance and referrals to consultants)	7	2	0	0
3. Selection Criteria				
• Selection of projects should be less political, more based on merit	1	2	4	0
• The selection criteria should be more development and less research oriented	3	4	3	0
• The selection criteria should adopt a longer-term focus in terms of economic development	2	20	4	0
• All core research projects should involve at least one collaborator from industry	4	4	0	0
• Greater consideration should be given to the social impacts of projects	0	3	0	0

During this period, the value of the grants awarded increased from $2.9 million to $10.5 million. Therefore, the cost of administration expressed as a percent of the value of grants awarded declined from 5.8% in 1986-87 to 4.6% in 1990-91. Given that the average administration cost for most grant programs we have evaluated in the past has ranged from 10% to 15% of the value of grants awarded, the Science Council represents a very cost-effective mechanism for delivering the Technology B.C. program.

7. **During the course of the evaluation, a wide variety of recommendations were received regarding ways in which the effectiveness of the Technology B.C. program could be improved.**

The Peer Review Committee representatives, proponents of approved applications, proponents of rejected applications, and non-applicants were asked whether they had any recommendations regarding how the effectiveness of the Technology B.C. program could be improved. The responses are summarized by type of respondent and topic area in Table 5.6. The results are useful in highlighting some of the more common concerns expressed by committee members and applicants. However, care should be taken in interpreting the responses, as the results may be effected by the incidence of various interest groups with the population of potential applicants and Peer Review Committee members and even the most commonly cited recommendations may be not shared by the majority. For example, one of the most commonly cited recommendation is that the project selection criteria should adopt a longer term focus in terms of the potential for economic development; however, the majority of the proponents and committee members felt that the existing criteria were appropriate given the objectives of the program. Similarly, strong support was expressed for the Peer Review Committee system although a number of respondents recommended that the committees be strengthened and that opportunities to shorten the length of the review process be examined.

TABLE 5.6, Continued

SUMMARY OF MAJOR RECOMMENDATIONS BY TYPE OF RESPONDENT

Recommendation	Peer Review Committee Members	Proponents	Rejected/ Withdrawn	Non-Applicants
4. Funding Guidelines				
• The definition of eligible expenses should be expanded	0	8	2	0
• There should be greater flexibility with respect to disbursements	2	9	0	0
• Funding for more than 3 years should be permitted in special circumstances	7	0	0	0
• Funding should be limited to 2 years or less	3	0	0	0
• Increase funding for core research	4	10	0	0
• Increase funding for industry based research	8	1	0	0
• Funding of more than 50% of costs should be permitted for small organizations or for projects with wide industry benefits	7	9	0	0
• Allow for flexibility in allocation of funding between core and industry based projects	5	3	0	0
5. Reporting Requirements				
• The reporting requirements should be streamlined	3	28	3	1
6. Total Funding				
• Total funding for the program should be increased	7	19	3	0

VI. CONCLUSIONS AND RECOMMENDATIONS

The major conclusions and recommendations arising from our review of the Science Council programs which provide financial assistance for applied research and development are as follows:

A. CONCLUSIONS

The major findings and conclusions arising from our evaluation of the AGAR and STDF programs are as follows:

1. **The STDF and AGAR programs have stimulated substantial incremental investment in research and development.**

   Based upon the survey results, it is estimated that the AGAR and STDF programs were, on average, the source of funding for 32.4% of the total costs of applied research and development projects which received funding from the Science Council. Therefore, approximately $2.09 was invested in the projects from other sources for every dollar contributed through the Science Council program. Of this $2.09 per dollar contributed, $1.56 was contributed by the proponent or a private sector organization, $0.47 was contributed by other government programs and $0.06 was obtained from other sources.

   It is estimated that 45% of the amount invested from other sources (approximately $42 million) was incremental in that it would not have been invested in the research and development projects in the absence of Science Council funding.

   In addition to the original research project, over 60% of the proponents surveyed indicated that the results of the Science Council funded project stimulated further research and development directly related to the technology. The incremental investment in additional research undertaken by the proponent organization totalled over $26 million.

2. **This research and development has been associated with the commercialization of at least 99 products and processes to date.**

Through in-depth interviews with proponents and by undertaking 10 mini-case studies, we were able to obtain detailed information on the commercial impacts of 96 of these products and processes. In addition to these commercialized products and processes, our survey identified a further 33 products and processes which are now in their final stages of development and will likely be commercialized in the next 2 to 3 years.

3. **Commercialization of these products and processes has stimulated significant incremental economic impacts.**

The economic impacts arising from commercialization of these 96 products and processes have been very substantial. However, not all of these impacts can be credited to the Science Council funding because, in many instances, it is possible that the product or process could have been commercialized even if the project had not been undertaken, or that the project could have been undertaken without Science Council funding. Based upon the survey results, it is estimated that about 65% of the economic benefits generated to date were truly incremental in that they would not have occurred in the absence of Science Council funding. This result is believed to be slightly above average for a program of this nature.

Incremental commercial impacts generated to date by these 96 products and processes, as expressed in 1991 dollars, include:

- Cumulative revenues and cost savings of $83 million. Over 70% of the revenues are derived from export sales. If we assume that the survey has quantified 80% of the actual benefits to date, the incremental revenues and costs savings attributable to the Science Council funded projects would be equal to $1.70 per dollar contributed under AGAR or STDF. In calculating the average return, the amount of funding provided under AGAR and STDF has also been expressed in 1991 dollars using the CPI.

  In addition, a further $116 million in incremental revenues and cost savings is projected to be generated by these 96 products and processes between 1992 and the year 2000. The projected revenues have been discounted back to 1991 at the rate of 20% per annum in order to reflect inflation and the

Table 6.1

SUMMARY OF INCREMENTAL RETURNS GENERATED PER DOLLAR OF SCIENCE COUNCIL FUNDING PROVIDED (1)

Type of Proponent	Revenues To Date	Revenues To the Year 2000	Capital Investment	Person Years
Industry	$ 2.64	$ 6.73	$ 0.11	2.33
University	0.89	1.66	0.04	1.06
Non-Profit	0.41	0.98	1.41	1.39
All Types	$ 1.70	$ 4.08	$ 0.19	1.71

Source: Survey of proponents of 96 commercialized projects

Note (1): Based on assumption that the evaluation quantified 80% of the economic impacts to date. All returns are expressed per dollar of funding provided, except for person years of employment which are expressed per $100,000 of funding provided.

level of risk associated with such long-term projections;

- Incremental capital investments, subsequent to the project, totalling about $9.2 million (equal to $0.19 per dollar contributed under AGAR or STDF assuming that the survey has quantified 80% of the actual benefits to date);

- The creation or maintenance of about 227 employment positions involving 830 person-years of employment. If we assume that the survey has quantified 80% of the actual employment benefits to date, approximately 1.71 person years of employment have been created for every $100,000 in funding contributed under AGAR and STDF.

- Indirect economic impacts on other B.C. organizations for at least 57 of the 96 commercialized products and processes. For at least five projects, which were the focus of case studies, the magnitude of these impacts was very substantial.

4. **Projects sponsored by industry (private sector) proponents have provided the greatest return to date per dollar of Science Council funding provided.**

   For example, if we assume that the survey has quantified 80% of the actual benefits to date, industry projects have generated average incremental revenues and costs savings to date of $2.64 per dollar contributed under AGAR or STDF as compared to an average of $0.89 for projects sponsored by proponents associated with universities and colleges as indicated in Table 6.1.

5. **The Science Council funding programs for applied research and development have also had a number of significant intangible impacts.**

   A number of Science Council funded projects have generated significant intangible benefits which, while difficult to measure, probably exceed their direct tangible economic impacts. For example, Science Council funded projects had significant impacts on the proponent organizations in terms of enhancing their technical knowledge and research capabilities, forging greater research linkages with other organizations, and increasing their willingness to invest in research and development. In addition, Science Council funded projects have contributed to a greater awareness of the Science Council, raised the profile of research and development in B.C., and benefited the general public through environmental, health and safety improvements.

6. **The need for further research was identified as the major constraint to commercialization for projects not yet commercialized.**

   Other leading reasons which were identified included the funding necessary for commercialization was not available, the organization did not have the technical or business capabilities required to directly implement the results, and a market sufficient to warrant commercialization was not identified.

7. **While there are a variety of other Federal and Provincial Government programs which may provide funding for applied research and development, the level of duplication or overlap has been minimized through a high degree of interaction between the Science Council and Federal Government departments and agencies and Government of B.C. ministries and agencies.**

   For example, the Peer Review Committees of the Science Council draw representatives from 7 agencies and departments of the Federal Government and 5 ministries of the Provincial Government. In addition, representatives of the Science Council are members of the review committees established for NSERC and IRAP-M which are the two programs which are most similar to Technology B.C. in terms of focus and client group. Project funding from the Science Council was often complemented by funding from other programs including, most notably, NSERC, IRAP, and FIRDA.

8. **The Science Council of B.C. has proven to be a very effective mechanism for delivering programs which provide financial assistance for applied research and development.**

   The major strengths of the delivery system are as follows:

- Through the Peer Review Committee system, a wide variety of representatives from government, industry and academia have provided input into the selection of projects.

- Awareness of Technology B.C. appears to be relatively high, particularly amongst research organizations located in the Lower Mainland and in Victoria.

- The majority of proponents rated program features such as the availability of information on the program, suitability of the eligibility requirements, clarity of the program guidelines, availability of advice upon applying to the program, and length of time between project approval and receipt of funds as satisfactory or better. In particular, the awards officers were praised by proponents for being of assistance during the application process as well as during implementation of the project.

  There was some concern expressed with respect to the reporting requirements (particularly amongst proponents associated with universities and colleges) and the length of time required for approval (particularly amongst private sector proponents), although the majority of proponents who expressed an opinion still found these features to be satisfactory. There were very few instances where the economic impacts generated by a project were constrained by program features such as the reporting requirements or the length of time required for approval.

- The majority of the Peer Review Committee members surveyed indicated that the eligibility criteria and funding guidelines established for the Technology B.C. programs are appropriate. However, there was support for increasing flexibility with respect to the allocation of funding between core research and industry based research, the definition of eligible project costs, and the proportion of total project costs for industry based research that must be funded by the proponent. In addition, it was recommended that the Science Council provide greater assistance to small and medium sized businesses in preparing proposals for funding.

- The Science Council represents a very cost-effective mechanism for delivering the Technology B.C. program. The cost of administration, expressed as a percent of the value of grants awarded, declined from 5.8% in 1986-87 to 4.6% in 1990-91. By comparison, the average administration cost for most grant programs we have evaluated in the past has ranged from 10% to 15% of the value of the grants awarded.

9. **There is no empirical data arising from the evaluation to justify the establishment of a mechanism to encourage the awarding of larger grants.**

There is no empirical data arising from the evaluation which suggests that the effectiveness of the applied research and development funding programs has been impaired by the limited number of large grants which have been awarded. In fact, many of the representatives we surveyed expressed the opinion that funding a large number of small projects was likely more effective in terms of promoting economic development and diversification than funding a few large projects.

10. **The need and demand for financial assistance for applied research and development in B.C. are projected to remain strong.**

The infrastructure for applied research and development in B.C. has further developed over the past five years and, consequently, there are now more individuals and organizations competing for funding. The majority of the proponents, responding to our survey, who received funding under AGAR or STDF indicated that they are "likely" or "extremely likely" to apply to the Science Council for applied research and development grant funding over the next few years.

According to most of the program, government and industry representatives surveyed, the need for financial assistance programs such as Technology B.C. which provide funding for applied research and development has increased over the past 3 to 5 years. It is widely recognized that a strong commitment to research and development is required if B.C. is to continue to compete successfully in an increasingly competitive global-based economy.

B. RECOMMENDATIONS

The major recommendations arising from our review of the Science Council programs which have provided financial assistance for applied research and development are as follows:

1. **The Government of B.C. should continue to provide significant financial support for programs such as Technology B.C. which provide financial assistance for applied research and development.**

   The results of this evaluation indicate that the AGAR and STDF programs have been successful in directly stimulating $42 million in research and development activity and another $26 million in subsequent research and development. The products and processes developed as a result of this activity have generated incremental revenues of over $83 million and over 800 person years of employment. The impacts of the projects funded under AGAR and STDF will continue to increase as 75 of the products and processes are still being marketed and a further 33 are expected to be commercialized within the next two to three years. The programs have also generated important indirect benefits which enhance B.C.'s ability to compete in a globally-based economy.

2. **In the allocation of funding, highest priority should continue to be given to industry based projects.**

   Projects sponsored by industry (private sector) proponents have provided the greatest return to date per dollar of Science Council funding provided. For example, we estimate that industry-based projects have generated average incremental revenues and costs savings to date of $2.64 per dollar contributed under AGAR or STDF as compared to an average of $0.89 for projects sponsored by proponents associated with universities and colleges.

   It should be noted, however, that this evaluation may serve to under-estimate the impact of core research projects to the extent that such projects may require a longer period of time before commercialization can occur. In addition, the impacts of university-based research may be more wide spread and, therefore, difficult to measure than are the impacts of projects sponsored by a private sector organization.

3. The Science Council should take steps to increase the proportion of applications received from private sector organizations.

In order to increase the demand for funding amongst private sector organizations, it is recommended that the Science Council:

- Focus its promotional efforts more directly on private sector organizations.

  Given that awareness amongst potential applicants from non-profit organizations and universities and colleges can adequately be generated through word-of-mouth (particularly referrals from other members of the same organization), the primary focus of the formal promotional program should be on increasing awareness of the Technology B.C. program in the private sector. It would also be useful to establish a system to evaluate the effectiveness of the promotional program. For example, a database could be constructed to monitor the number of applications received by region and the number of applications received from applicants who have never applied to the Science Council for applied research and development funding in the past. In addition, a random survey could be conducted to estimate the level of awareness amongst industry representatives.

- The Science Council should make greater use of seminars, workshops and other face-to-face mediums to promote Technology B.C. to small and medium sized businesses.

  These seminars and workshops should be targeted not only at potential applicants, but also at potential intermediaries and referral sources such as regional economic development officers, industry associations, community colleges, and NRC Industrial Technology Advisors.

- Where the potential impacts are significant and the applicant does not have the necessary resources to undertake the project without additional financial assistance, the Peer Review Committees should have the option of recommending funding of more than 50% of the project costs.

- Greater assistance in the preparation of proposals should be made available to small and medium sized businesses.

  Concern was expressed by a number of Peer Review Committee members that potentially very useful research projects were not being funded because the proponents are not capable of preparing an adequate proposal. Such proponents could be dissuaded from applying to the program by the need to prepare a detailed proposal or be rejected because the quality of proposal was poor or it was incomplete technically. To ease this constraint, it was recommended that the Science Council conduct seminars and workshops to assist potential applicants in preparing applications, provide direct assistance in some situations, and establish a referral service through which potential applicants could be referred to individuals and organizations who could be of assistance in the preparation of proposals.

- The application form should be revised to make it less intimidating for small and medium sized businesses.

  The application form appears to be targeted at researchers from universities and colleges or from large research organizations and, therefore, may serve to discourage applicants from small and medium sized private sector organizations.

- Within the existing approval structure, and provided that the quality of the adjudication process is not affected, options to reduce the turn around time on applications should be examined.

  The application review system is one of the major strengths of the Technology B.C. program. However, the length of time from submission to approval was identified by private sector respondents as a constraint to private sector applications.

4. **The Science Council should strive to establish a greater presence outside of the Lower Mainland and Victoria areas.**

A greater emphasis should be placed on creating awareness and encouraging applications from firms located outside of the Lower Mainland and Victoria. Over 85% of program funding has been awarded to organizations in the Lower Mainland and 99% has been awarded to organizations in the Lower Mainland or on Vancouver Island. In addition to targeting the interior through advertising, seminars and workshops, the Science Council should establish greater links with regional ITA's, regional development officers, and other potential referral agencies as well as with the regionalization initiative established within MAETT.

5. **Options should be considered to improve the effectiveness of the application review process with respect to the assessment of potential economic impacts.**

In general, a thorough review of applications is performed with respect to its scientific and technical merits, proponent capabilities and resources, and project budget and time frame. However, concerns have been raised regarding the review of the economic potential of the proposed project. In order to improve the review process with respect to assessment of economic potential, it is recommended that:

- A greater emphasis in the application should be placed on identification of the potential market, competition and commercial risks associated with the proposed product or process. In addition, a description of the specific steps that would be undertaken in moving the product or process from the research stage to commercialization should be provided. Most proposals do not contain a sufficient discussion of the size of the potential market and the competitive situation to enable Peer Review Committee members to assess the reasonability of the estimates of potential revenues, costs savings and employment provided.

- Where warranted by the size of the grant being considered and concerns regarding the economic potential, input should be obtained from at least one external reviewer regarding the market potential of the proposed product or process and the prospects for commercialization.

6. **Consideration should be given to providing unsuccessful applicants with more detailed information on the reasons leading to the rejection of their application.**

The current form letters used by the Science Council to communicate rejection provide very little specific information on the reasons leading to that decision. Because of the time involved in preparing and submitting an application, a number of Peer Review Committee members and proponents surveyed expressed concern that this policy may discourage unsuccessful applicants from applying again, and that those deciding to re-apply are not given a chance to identify and correct the deficiencies of their initial application.

7. **Consideration should be given to introducing greater flexibility with respect to the program funding guidelines.**

While the general structure of the Technology B.C. program appears to be very appropriate and well designed, situations occasionally do arise where the objectives of the program may not be best served by following the funding guidelines. In particular, it is recommended that the Peer Review Committees be permitted greater flexibility with respect to the allocation of funding between core research and industry based research (for example, restating the guidelines in terms of a range), the definition of eligible project costs, and the proportion of total project costs for industry based research that must be funded by the proponent.

APPENDIX 1

LIST OF REPRESENTATIVES SURVEYED

PEER REVIEW COMMITTEE MEMBERS AND PROGRAM REPRESENTATIVES

R. Armstrong	Aquatic Resources
David Barbour	Aquatic Resources
J.E. Barker	Forestry
C.R. Barnes	Aquatic Resources
Derek Barnes	Forest Products
Ron Bertrand	Agriculture and Food
V.K. Bhargava	Electronics and Communication
Neil Bourne	Aquatic Resources
S.W. Campbell	Mining, Minerals and Metals
Reid Carter	Forestry
David Cheng	Manufacturing and Machinery
D.K. Chowdhury	Computers and Computing
F.G. Claggett	Environmental Technology and Waste Management
Pat Collins	Health Technology
Sandy Constable	Energy
D.A. Draper	Forestry
Ralph Drew	Aquatic Resources
B. Dunwoody	Manufacturing and Machinery
Karol Dusil	Mining, Minerals and Metals
Abul Ekramoddoullah	Biotechnology
Derek Ellis	Environmental Technology and Waste Management
Ron Evans	Health Technology
Lorne Fisher	Agriculture and Food
Alvin Fowler	Computers and Computing
Norm Francis	Computers and Computing
Donald Furnell	Aquatic Resources
Andrew Garner	Forest Products
Don Giles	Forest Products
Grant Gisel	Computers and Computing
Ellen Godfrey	Computers and Computing
Arnold Greenius	Mining, Minerals and Metals
Ian Greenwood	Agriculture and Food
T. Haksi	Computers and Computing

Chris Hawkins	Forestry
Bill Hennessey	Energy
Christine Hodgson	Aquatic Resources
D.J.L. Hughes	Computers and Computing
Bryan Imber	Environmental Technology and Waste Management
George Iwama	Aquatic Resources
John Jones	Manufacturing and Machinery
D.G. Kilburn	Biotechnology
Charles Laszlo	Health Technology
Denis Lavender	Forestry
Julia Levy	Biotechnology
Kathy Lewis	Forestry
Warren Little	Forest Products
Thomas Madden	Biotechnology
Bill Matson	Forest Products
Anne Mauch	Forest Products
John Maw	Manufacturing and Machinery
J. McEwen	Manufacturing and Machinery
R. McKay	Mining, Minerals and Metals
Brian McKeown	Aquatic Resources
Greg McKillop	Mining, Minerals and Metals
K.V.S. Meyer	Mining, Minerals and Metals
Tod Needham	Aquatic Resources
Don O'Connor	Energy
Doug Oldenburg	Mining, Minerals and Metals
Larry Olsen	Forest Products
Robert Orth	Electronics and Communications
W.D. Powrie	Agriculture and Food
Z.K. Punja	Agriculture and Food
Gerry Reimer	Environmental Technology and Waste Management
H. Reynolds	Health Technology
S. Rhodes	Biotechnology
T. Richardson	Health Technology
Don Roberts	Biotechnology
C. Ryan	Manufacturing and Machinery

Alex Sinclair	Forestry
A.J. Sinclair	Mining, Minerals and Metals
David Sloan	Electronics and Communications
B. Smith	Computers and Computing
Roy Smyth	Electronics and Communications
Norman Streat	Energy
Jack Sutherland	Forestry
B. Tabarrok	Manufacturing and Machinery
Patrick von Aderkas	Forestry
J.B. Wallace	Environmental Technology and Waste Management
P.D. Warrington	Environmental Technology and Waste Management
Iain Weir-Jones	Mining, Minerals and Metals
Lorne Whitehead	Manufacturing and Machinery
Mark Winston	Agriculture
Bob Woodley	Energy
Irwin Woodrow	Agriculture and Food
Ian Yellowley	Manufacturing and Machinery
Gavin Young	Agriculture and Food
Des Mullan	National Research Council
Rick Warner	Science Council Staff
Chris Crossfield	Science Council Staff
Vincent Lum	Science Council Staff
Max Cairns	Science Council Staff
Terry Chanyungco	Science Council Staff

NON-APPLICANTS

Mr. Brian Bolton	Forest Technology Systems Inc. (FTS)
Mr. Mike Boudreau	Novax Industries
Mr. Neil Duke	Target Products Ltd.
Mr. Bruce Elliott	Nissi Technologies Inc.
Mr. Don Gaton	Glenayre Electronics Ltd.
Mr. Don Gilmore	B.C. Certified Seed Potato Association
Mr. Michael Goldstein	Soilcon Laboratories
Mr. Joe Hailey	United Industrial Products Ltd.
Mr. Stevel Hall	Mandat Systems Ltd.
Mr. Hugh Kay	Circuit Graphics Ltd.
Mr. Gary McIntosh	GDT Softworks Inc.
Mr. Mulgi	Triton Technologies
Dr. Frank Patton	Westbay Instruments Inc.
Mr. Alan Pemberton	Chemetics International Ltd.
Mr. Gordon Stewart	Porter Engineering Ltd.
Mr. Kevin Walker	International Place Autopark
Mr. Glyn Welsh	B.C. Turkey Association
Mr. Whaley	B.C. Blueberry Co-op Association
Mr. Mark Wong	Bion Research Inc.

REPRESENTATIVES SURVEYED REGARDING SPECIFIC PROJECTS FUNDED UNDER AGAR AND STDF

Boyd Ahlborn	University of British Columbia, Physics
Lawrence Albright	Silver Spring Aquaculture Corporation Simon Fraser University, Biological Sciences
Michael Alexander	Canadian Forest Products Ltd.
Ray Alford	Chemetics International Ltd.
Eric Amlin	FERIC
Craig Anderson	Industrotech Sales Ltd.
Dr. Ashwood-Smith	University of Victoria, Biology
Geoffrey Auchinleck	Andronic Devices Ltd.
Alan Austin	University of Victoria, Biology
Gerald Bachmayer	Oracle Communications Inc.
Robert Baden	Ocean Shellfish Ltd.
Karl Baker	FC McKenzie
Wilson Baker	Tetrad Computer Applications Ltd.
T.M. Ballard	University of British Columbia, Soil Sciences
J.D. Barrett	University of British Columbia
Gordon Bates	University of British Columbia, Chemistry
Richard Beames	University of British Columbia, Animal Sciences
Tom Bell	Simon Fraser University, Chemistry
Peter Berrang	Seastar Instruments Ltd.
Vijay Bhargava	University of Victoria, Electrical & Computing Engineering
Gary Birch	Neil Squire Foundation
Alex Birkbeck	B.C. Research Corporation
Thomas Black	University of British Columbia, Soil Sciences
Robert Blair	University of British Columbia, Animal Science
Danford Bodrug	Applied Microsystems Ltd.
Graham Boffey	Royal Inland Hospital
Art Bomke	University of British Columbia, Soil Sciences
Max Bonneau	Biotronics Development Corp.
John Borden	Simon Fraser University, Biological Sciences
Eric Boucher	Pacific Aquafoods Ltd.
Eric Bowman	Western Lettuce

Don Boyd	Talkie Tooter Canada
Ken Bradley	Modatech Systems Inc.
Klaus Brandt	Moli Energy Ltd.
Richard Branion	University of British Columbia, Bio-Resource Engineering
Carroll Brawner	University of British Columbia, Mining/Mineral Process Engineering
Jan Brdicko	CETEC
Raymond Breckner	Innovac Technology Inc.
Ian Brown	Cymbolic Technologies
Isidor Buchmann	Cadex Electronics Inc.
Fred Bunnell	University of British Columbia, Forestry
Christina Burridge	Fisheries Council of British Columbia
Helen Burt	University of British Columbia, Pharmaceutical Sciences
Bruce Burton	Nobiotics Laboratories Ltd. B.C. Research Corporation
Neil Bylenga	Ground Effect Wholesale Nurseries
Thomas Calvert	Simon Fraser University
William Cameron	Neil Squire Foundation
David Camm	Vortek Industries Ltd.
Edith Camm	University of British Columbia, Botany
Dan Camporese	Techware Systems Corp.
Patrick Capozzi	Pan-Abode International Ltd.
Art Carson	Carson Electronics
William Caselton	University of British Columbia, Civil Engineering
Al Castledine	British Columbia Ministry of Agriculture and Fisheries
Jim Cavers	Simon Fraser University, Engineering Science
Asoke Chaklader	University of British Columbia, Metallurgical Engineering
C.P. Chanway	University of British Columbia, Forestry
John Chapman	Microtel
Peter Chapman	E.V.S. Consultants Ltd.
Kimberley Cheng	University of British Columbia, Poultry Sciences
Dr. Cherchas	University of British Columbia, Mechanical Engineering
H.L. Ching	Hydra Enterprises Ltd.
Brian Christie	Christie Nursery Ltd.
Joseph Chuma	Integral Mathware Inc.
Mark Clark	FERIC

Reginald Clements	University of Victoria, Physics
Konrad Colbow	Simon Fraser University, Physics
Terry Connelly	Columbia Computing Service
Denis Connor	Corporate Development, MDA
P.R. Cullis	University of British Columbia, Biochemistry
Vladimir Cuperman	Simon Fraser University, School of Engineering
Francis Curzon	University of British Columbia, Physics
Barry Dashner	Dynamic Control Systems
John Davidson	Quanta Trace Laboratories
J. Dewey	Dewey McMillin & Associates Ltd.
Chris Dewhurst	Capilano Computing Systems Ltd.
John Dill	Simon Fraser University, Engineering Science
Brian Dillistone	Wee-Do System Ltd.
David Dolphin	Quadra Logic Technologies Inc.
Robert Donaldson	University of British Columbia, Electrical Engineering
Ralph Drew	Canadian Fishing Company
Louis Druehl	Simon Fraser University, Institute of Aquatic Resources
Carole Duerden	University of British Columbia, Metals and Materials
Neil Duke	Target Products Ltd.
Guy Dumont	University of British Columbia
Tim Durance	University of British Columbia, Food Sciences
Stephen Eady	Speech Technology Research Ltd.
Don Elliott	Applied Bio-Nomics Ltd.
Robert Evans	University of British Columbia, Mechanical Engineering
Ron Evans	B.C.'s Children's Hospital
Mike Feller	University of British Columbia, Forestry
Josef Fikart	MPR Teltech Ltd.
William Fletcher	University of British Columbia, Geological Sciences
Brian Flintoff	Brenda Mines Ltd.
John Folkerts	Reid Collins Nurseries
Thomas Foxall	Bridgenorth Signal Processing Inc.
R.F. Frindt	Simon Fraser University, Physics
B. Funt	Simon Fraser University, Computing Science
Ian Gartshore	University of British Columbia, Mechanical Engineering
Daniel Gelbart	CREO Products Inc.

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Roger Gibb	B.C. Packers Ltd.
Norman Gibbons	Redonda Sea Farms Ltd.
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Douglas Golding	University of British Columbia, Forestry
James Gordie	B.C. Cancer Agency
Karen Graham	B.C. Research Corporation
Diane Gray	University of Victoria, Biology
David Gregson	Sierra-Misco Environment Ltd.
Claudio Guarnaschelli	Turborator Technology Ltd.
Sharon Hadden	Fanny Bay Oyster Co.
Peter Hall	British Columbia Forest Service
Dr. Hall	University of British Columbia, Westwater Research Centre
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Chris Hannah	A.L.I. Technologies
Michael Hansmann	Techware Systems Corp.
Brian Harvey	MTL Biotech
Craig Hawryshyn	University of Victoria, Biology
John Helliwell	University of British Columbia, Economics
Deborah Henderson	E.S. Cropconsult Ltd.
Paul Hickson	P & C Hickson Associates Inc.
James Hill	Innovac Technology Inc.
Philip Hill	University of British Columbia, Mechanical Engineering
Mr. Ho	PMC Telesystems
Richard Hobson	Simon Fraser University, Computing Sciences
Bruce Hodgins	University of British Columbia, Mechanical Engineering
Donald Hodgins	Seaconsult Marine Research Ltd.
James Hudson	University of British Columbia, Medical Microbiology
Kevin Huscroft	MPR Teltech Ltd., PMC Division
Gerry Hutchinson	New Leaf Enterprises
Stanley Hutton	University of British Columbia, Mechanical Engineering
Elizabeth Huxter	B.C. Bee Breeders Association
Branco Hyrman	EMT Corp. Cheakamus Holdings Ltd.
Brian Imber	CB Research International Corp.
Randle Iredale	The Iredale Partnership

Pat Irvine	B.C. Oyster Growers Association
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Eric Jackson	International Submarine Engineering Research
P. Jolliffe	University of British Columbia, Plant Sciences
William Kay	Microtek Research & Development Ltd.
Bowie Keefer	Highquest Engineering
John Keightley	Pthalo Systems Inc.
Barbara Kelly	Quadra Logic Technologies Inc.
Michael Kelly	University of British Columbia, Medical Microbiology
R.J. Kerekes	University of British Columbia, Pulp & Paper Centre
Kurt Kerkovius	Microtel
John Kidder	CST Coldswitch Technologies
Douglas Kilburn	University of British Columbia, Microbiology
James Kimmins	University of British Columbia, Forest Sciences
L. Kirlin	University of British Columbia, Electrical Engineering
David Kitts	University of British Columbia, Food Science
Karel Klinka	University of British Columbia, Forestry
Shan Krannitz	Phero Tech Inc.
Walden Kunz	KIS Information Systems Inc.
Charles Laszlo	University of British Columbia, Clinical Engineering
Charles Lau	Simon Fraser University
Howard Leach	Halco Software Systems Ltd.
Bill Leathem	Oversea Casing Company Ltd.
D.F. Leclerc	Paprican
Malcolm Lefcort	Heuristic Engineering Inc.
David Lemon	Arctic Sciences Ltd.
Ken Leong	VSI Vision Systems Inc.
Albert Leung	Intertech Systems Inc.
Staffan Lindgren	Phero Tech Inc.
Jack Lindsay	Canadian Benthic Ltd.
Sandra Lindstrom	Nori Aquafood Systems Inc.
Monty Little	Syndel Laboratories Inc.
Vern Little	MPR Teltech Ltd., PMC Division
Jack Littlepage	University of Victoria, Biology
Kitty Lloyd	Barclay Sound Kelp

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D.E. Lobb	University of Victoria, Physics
Steve McAlister	Canadian Gold Centrifuge Co. Ltd.
Jack McCubbin	CTF Systems Inc.
Bruce MacDonald	University of British Columbia, Botanial Garden
Gary McIntosh	GDT Softworks Inc.
Jim McIntosh	GDT Softworks Inc.
John MacKay	Forintek Canada Corporation
Alec MacKenzie	Argus Controls
Ken McLaren	Cymbolic Technologies
Richard McMahon	Techware Systems Corp.
Howard Malm	TIAC Manufacturing Inc.
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Patrick Mann	Nexus Engineering
Beryl March	University of British Columbia, Animal Sciences
Brian Mauza	Western Greenhouse Growers Co-op
Donald Mavinic	University of British Columbia, Civil Engineering
Axel Meisen	University of British Columbia, Chemical Engineering
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Santosh Misra	University of Victoria, Biochemistry
Alec Mitchell	University of British Columbia, Metallurgical Engineering
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Stanley Morrison	Simon Fraser University, Physics
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Patrick Murray	Pacific Aqua Foods Ltd.
Peter Murtah	University of British Columbia, Forestry
Shuryo Nakai	University of British Columbia, Food Science
Barry Narod	Narod Geophysical
Dan Nomura	Canadian Fishing Company
Phil Nuytten	International Hard Suits Inc.
Chris Nyberg	ARC Sonics Inc.
Dr. O'Brien	University of Victoria
Klaus Oehr	B.C. Research Corporation
Roy Oetter	Albacone Research Ltd.

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Colin Oloman	University of British Columbia, Chemical Engineering
Tony Orlitsky	ATS Electrolube Ltd.
Calvin Osborne	Andronic Devices Ltd.
John Owens	University of Victoria, Biology
Branko Palcic	B.C. Cancer Agency
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Brian Pate	University of British Columbia, TRIUMF
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Frank Peabody	Statpower Technologies Corp., University of British Columbia
Philip Pearsall	British Columbia Nursery Trades Association
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Ray Peterson	University of British Columbia, Animal Sciences
Kenneth Pinder	University of British Columbia, Chemical Engineering
George Plant	MacMillan Bloedel Research
Don Pollard	McMillan Fisheries
Mike Pottie	Canadian Stress-Tek
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James Rahe	Simon Fraser University, Biological Sciences
Avaral Rav	Powertech Labs
Andrew Rawicz	Simon Fraser University Andrew Engineering Inc.
R.F. Redden	Crystar Research Inc.
Alan Reed	Energy, Mines and Resources
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Richard Ring	University of Victoria, Biology
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Douglas Romilly	University of British Columbia, Mechanical Engineering
Ross Rose	MacDonald Dettwiler & Associates
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Carl Saunders	Shape Technologies Inc.
Frank Schrack	Western Packaging Systems Ltd.
Guenther Schrack	University of British Columbia, Electrical Engineering
Hans Schreier	University of British Columbia, Soil Sciences
John Schroeder	Valleybrook Gardens
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Roger Simpson	Petrosul
Alex Sinclair	FERIC
Brent Skura	University of British Columbia, Food Sciences
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George Von Westarp	MacMillan Bloedel
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John Whalen	Microlight Graphics
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Mr. Wong	Microtel Pacific Research Ltd.
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Adam Zielinski	University of Victoria, Electrical Engineering
Hermann Ziltener	University of British Columbia, Biomedial Research Centre

APPENDIX 2

COMPARISON WITH THE 1987 EVALUATION

COMPARISON WITH THE 1987 EVALUATION

A previous evaluation of the AGAR program was undertaken in 1987. For the purposes of this study, information was generated on the economic impacts resulting from the commercialization of 96 products and processes, including 50 products and processes which were identified and covered in the 1987 evaluation. The results of the two studies are very similar in many respects. However, the revenues and cost savings generated between 1979 and 1990 were, in the 1987 evaluation, estimated to represent about $6.20 per dollar of funding provided, as compared to $1.70 in our evaluation. Including projected revenues and cost savings to the year 2000, the revenues and cost savings were, in the 1987 evaluation, estimated to represent $17.21 per dollar of funding provided as compared to $4.08 in our evaluation. These discrepancies were, for the most part, the result of four significant differences in the approach and the methodology used in the studies, as indicated below:

- Throughout this report, the returns were computed on the basis of the total amount of funding received by all projects, commercialized or not.

  By comparison, the returns in the 1987 evaluation were expressed on the basis of the funding received by commercialized projects only, and thus overestimated the actual returns per every dollar of funding provided. Indeed, based on the figures of the 1987 study, actual returns per dollar of funding were only $4.95 as of 1990 (versus $6.20) and $13.73 to the year 2000 (versus $17.21).

- This study attempted to specifically identify both how instrumental the Science Council funding was to undertaking the project and how instrumental the project was in the commercialization of the product or process.

  By contrast, in the 1987 evaluation, respondents were only asked to provide an estimate of the total economic benefits generated by the Science Council funded projects and of the proportion of these benefits that could be attributed to the Science Council funding. Benefits attributable to the Science Council were then computed by multiplying these 2 figures. This approach focused on the role played by the Science Council funding in the Science Council funded project, but may not have taken into account the importance of that project in the overall commercialization process, or the possibility that the resulting products or processes could have been commercialized even if the Science Council funded project had not been undertaken. As a result, this approach likely resulted in an overestimation of the benefits attributed to the Science Council funding. Interestingly, the impacts reported in the 1987 evaluation were very similar to those we identified as **attributable** impacts in the body of the report.

- In this study, both the economic impacts and the Science Council contributions were restated to a common year.

  In the 1987 evaluation, the concept of present value was not taken into account and neither the total amount of funding provided nor the economic benefits generated by the projects were adjusted and restated to a common year. This in turn contributed to an overestimation of the ratio of revenues and cost savings generated per dollar of funding provided.

  Indeed, had we not restated all dollar amounts to a common year (1991) using the Consumer Price Index, cumulative revenues and cost savings to date would have been about $72.2 million (versus $82.9 million as expressed in 1991 dollars) while total Science Council contributions would have been about $45.2 million (versus $60.9 million in 1991 dollars). Assuming that our evaluation captured 80% of all projects leading to commercialization, we would have found that $2.00 in incremental revenues and cost savings were generated per dollar of funding provided, when in fact this ratio is only $1.70 if one takes the time value of money into account.

- In this study, the projected economic impacts were discounted at the rate of 20% per annum to reflect inflation and the level of risk associated with such long-term projections.

  We asked proponents to develop long-term revenue and cost savings projections for each of the 96 projects covered in our report. Because these projections were substantially higher than the benefits realized to date, and because of the very competitive nature of the advanced technology sector, we discounted these projections provided by respondents at 20% per annum in order to account for inflation and for the level of risk associated with such long-term projections.

By comparison, the 1987 evaluation developed long-term revenue and cost-savings projections for all 50 commercialized projects at the time, based on only 13 major projects. Notwithstanding the fact that these 13 projects may not have been representative of all the commercialized projects at the time, the projections derived were not systematically discounted to reflect level of the risk. By discounting all revenues between 1992 and the year 2000 at 20% per annum in the 1987 evaluation, cumulative revenues to the year 2000 would represent only about $192.3 million (versus $297.8 million when no discount rate is applied), or a return of $8.87 per dollar of funding provided (versus $13.73).